USER MANUAL 1.3

E-I/O
EtherCAT® I/O Modules

BERGHOF

Copyright © Berghof Automationstechnik GmbH
Reproduction and duplication of this document and utilisation and communication of its content is prohibited, unless with our express permission. All rights reserved. Damages will be payable in case of infringement.

Disclaimer

The content of this publication was checked for compliance with the hardware and software described. However, discrepancies may arise, therefore no liability is assumed regarding complete compliance. The information in this document will be checked regularly and all necessary corrections will be included in subsequent editions. Suggestions for improvements are always welcome.
Subject to technical changes.

Trademarks

- → CANtrol® and CANtrol®- dialog are registered trademarks of Berghof Automationstechnik GmbH
- → Microsoft®, Windows® and the Windows® Logo are registered trademarks of Microsoft Corporation in the USA and other countries.
- → EtherCAT® is a registered trademark and patented technology, licensed from Beckhoff Automation GmbH, Germany.
- → CiA® and CANopen® are registered community trademarks of CAN in Automation e.V.

All rights reserved by the individual copyright holders.

General Information on this Manual

→ Content
→ Completeness

This equipment manual contains product-specific information valid at the time of publication.
This equipment manual is only complete in conjunction with the product-related hardware and software user manuals required for the individual application.

You can reach us at:
Berghof Automationstechnik GmbH
Harretstr. 1
72800 Eningen
Germany
T +49.7121.894-0
F +49.7121.894-100
e-mail: controls@berghof.com
www.berghof.com

Berghof Automationstechnik GmbH works in accordance with DIN EN ISO 9001:2000.

Update

Version	Date	Subject
1.01	16.10.2012	First Version
1.1	09.11.2012	Update of document title and the trademarks
1.2	04.04.2013	Transition in new CD Update of chapter ‘Temperature modules’ with module AI8-Pt/Ni100 Update of ‘Technical data‘ in all chapters
1.3	25.07.2013	Update of tables ‘Analogue values current‘ and ‘Analogue values voltage’ Update of table ‘Analogue outputs’ in chapter ‘Analogue outputs voltage / current AO4-U/I’, section ‘Function’

Blank page

Contents

1. GENERAL INFORMATION 9
1.1. About This Manual 9
1.2. Hazard Categories and Terminology 10
1.3. Conformity Declaration 10
1.4. Qualified Personnel 11
1.5. Due Diligence 11
1.5.1. Working on the controller module 11
1.6. Use as Prescribed 12

2. INTRODUCTION ETHERCAT I/O MODULES 13
2.1. EtherCAT - Ethernet Control Automation Technology 13
2.2. CANtrol - the automation platform 13
2.3. E-I/O - CANtrol EtherCAT I/O-System 14
2.4. Electromagnetic compatibility 15
2.4.1. Definition 15
2.4.2. Interference emission 15
2.4.3. General notes on installation 15
2.4.4. Electrical immission safeguard 15
2.4.5. Cable routing and wiring 16
2.4.6. Location of installation 16
2.4.7. Particular sources of interference 16

3. SYSTEM DESCRIPTION ETHERCAT I/O MODULES 17
3.1. Mechanical design 17
3.1.1. Earth 18
3.1.2. Installation 19
3.2. System power supply 20
3.2.1. General 20
3.2.2. Bus coupler 20
3.2.3. I/O Modules 20
3.3. Status LEDs 21
3.3.1. “EtherCAT” LED 21
3.3.2. “In” LED, “Out” LED 21
3.3.3. “I/O” LED 21
3.3.4. “Power” LED 21

4. BUS COUPLER 23
4.1. Terminals 23
4.2. Status LEDs 23
4.3. Function 24
4.4. Technical data 25

5. DIGITAL MODULES 27

5.1. Digital in- and outputs DI16 / DO16 27
5.1.1. Terminals 27
5.1.2. Status LEDs 27
5.1.3. Function 29
5.1.4. Technical data 29
5.2. Digital inputs DI32 30
5.2.1. Terminals 30
5.2.2. Status LEDs 30
5.2.3. Function 31
5.2.4. Technical data 31
5.3. Digital inputs DI16 32
5.3.1. Terminals 32
5.3.2. Status LEDs 32
5.3.3. Function 33
5.3.4. Technical data 33
5.4. Digital outputs DO16 34
5.4.1. Terminals 34
5.4.2. Status LEDs 34
5.4.3. Function 35
5.4.4. Technical data 36

6. ANALOGUE MODULES 37
6.1. Analogue inputs for current measurement AI4-I 37
6.1.1. Terminals 37
6.1.2. Status LEDs 37
6.1.3. Function 38
6.1.4. Technical data 43
6.2. Analogue inputs for current measurement AI8-I 44
6.2.1. Terminals 44
6.2.2. Status LEDs 44
6.2.3. Function 45
6.2.4. Technical data 50
6.3. Analogue inputs for voltage measurement AI4/8-U 51
6.3.1. Terminals 51
6.3.2. Status LEDs 51
6.3.3. Function 52
6.3.4. Technical data 56
6.4. Analogue outputs voltage / current AO4-U/I 57
6.4.1. Terminals 57
6.4.2. Status LEDs 57
6.4.3. Function 59
6.4.4. Technical data 61

7. TEMPERATURE MODULES 63
7.1. Analogue temperature inputs AI4-Pt/Ni100, AI4-Pt/Ni1000 63
7.1.1. Terminals 63
7.1.2. Status LEDs 63
7.1.3. Function 64
7.1.4. Technical data AI4-Pt/Ni100 68

7.1.5. Technical data AI4-Pt/Ni1000 ... 69

7.2. Analogue temperature inputs AI8-Pt/Ni100 ... 70
7.2.1. Terminals ... 70
7.2.2. Status LEDs ... 70
7.2.3. Function ... 71
7.2.4. Technical data AI8-Pt/Ni100 ... 75

7.3. Analogue temperature inputs AI4 ... 76
7.3.1. Terminals ... 76
7.3.2. Status LEDs ... 76
7.3.3. Function ... 77
7.3.4. Technical data ... 80

8. COMMUNICATION MODULES ... 81

8.1. PROFIBUS-DP-Slave ... 81
8.1.1. Terminals ... 81
8.1.2. Status LEDs ... 81
8.1.3. Function ... 82
8.1.4. Technical data PROFIBUS-DP-Slave ... 86

9. COUNTER MODULES ... 87

9.1. Counters with analogues outputs Counter/Posi2 5V, Counter2 5V ... 87
9.1.1. Terminals ... 88
9.1.2. Status LEDs ... 88
9.1.3. Function ... 90
9.1.4. Controlling and watching the entire module ... 91
9.1.5. Controlling / Watching Counter 1 ... 92
9.1.6. Counter values of Zähler 1 (Counter 1) ... 94
9.1.7. Digital I/Os ... 95
9.1.8. Analogue outputs (Counter/Posi2 5V only) ... 99
9.1.9. Examples ... 100
9.1.10. Technical data ... 105

10. EXTENDER ... 107

10.1. Extender 2 Port ... 107
10.1.1. Terminals ... 107
10.1.2. Status LEDs ... 108
10.1.3. Function ... 108
10.1.4. Technical data ... 109

11. SUPPLEMENT ... 111

11.1. Potential Distributor 2 x 16 ... 111
11.1.1. Terminals ... 111
11.1.2. Status LEDs ... 111
11.1.3. Function ... 111
11.1.4. Technical data ... 112

11.2. Shield connection terminal block ... 112
11.2.1. Terminals ... 112
11.2.2. Function ... 113
11.2.3. Technical data ... 113

12. ANNEX 115
12.1. Environmental Protection 115
12.1.1. Emission 115
12.1.2. Disposal 115
12.2. Maintenance/Upkeep 115
12.3. Repairs/Service 115
12.3.1. Warranty 115
12.4. Nameplate 116
Nameplate descriptions (example) 116
12.5. Addresses and Bibliography 117
12.5.1. Addresses 117
12.5.2. Standards/Bibliography 118

1. General Information

Documentation
This equipment manual is intended for qualified personnel and contains information regarding mounting, installation, commissioning and maintenance. The information contained in this manual is subject to change without prior notice.

1.1. About This Manual

This equipment manual is an integral part of the product. Make sure the equipment manual is always available near the product's point-of-employment. The manual contains information about the following topics:

- → Areas of application;
- → Safety;
- → Mechanical construction;
- → Electrical construction;
- → Connections;
- → Commissioning;
- → Care and maintenance;
- → Decommissioning;
- → Disposal.

1.2. Hazard Categories and Terminology

DANGER	**Immediate danger** Failure to observe the information indicated by this warning will result in death, serious injury or extensive property damage.
WARNING	**Potential danger** Failure to observe the information indicated by this warning may result in death, serious injury or extensive property damage.
CAUTION	**Danger** Failure to observe the information indicated by this warning may result in injury or property damage.
NOTICE	**No hazard** Information indicated in this manner provides additional notes concerning the product.

1.3. Conformity Declaration

The EtherCAT I/O Modules comply with and make allowance for the following directives and standards

→ **EMP Directive 2004/108/EC**

→ **DIN EN 61131-2:2009-1** Programmable controllers
Part 2: Equipment requirements and tests

→ **DIN EN 61000-6-2:2011-06** Electromagnetic compatibility (EMP)
Part 6-2: Generic standard – immunity for industrial environments

→ **DIN EN 61000-6-4:2011-9** Electromagnetic compatibility (EMP)
Part 6-4: Generic standard – electrostatic discharge for industrial environments

1.4. Qualified Personnel

Only qualified personnel may install, operate and maintain the EtherCAT I/O Modules.
Within the context of this documentation and the safety information it contains, qualified personnel constitutes trained specialists who have the authority to mount, install, commission, ground and identify equipment, systems and power circuits in accordance with the standards of safety technology, and who are familiar with the safety concepts of automation technology.

1.5. Due Diligence

The operator, or the processor (OEM) must ensure that

- → the EtherCAT I/O Modules are only used for the purpose for which they are intended;
- → the EtherCAT I/O Modules are only operated in impeccable full working order;
- → the user manual is always available in full and in a legible condition;
- → only specialists with sufficient qualification and authorisation mount, install, commission and maintain the controller module;
- → these specialists are regularly instructed in all relevant questions of occupational health and safety and environmental protection and that they also know the contents of the user manual and especially of the safety notes therein;
- → the device markings, identifications, safety and warning notes attached to the EtherCAT I/O Modules are not removed and are always kept in a legible state;
- → the national and international regulations for controlling machines and systems which apply at the relevant usage site are observed;
- → the relevant information about the EtherCAT I/O Modules and their application and operation is always available to the users

1.5.1. Working on the controller module

Before carrying out work on the EtherCAT I/O Modules you must always

- → first ensure that the controller and the system are in a secure state;
- → only then switch off the controller and the system and
- → only now disconnect the EtherCAT I/O Modules from the system.

1.6. Use as Prescribed

This is a modular automation system based on the CANbus, intended for industrial control applications within the medium to high performance range.
The automation system is designed for use within Overvoltage Category I (IEC 364-4-443) for the controlling and regulating of machinery and industrial processes in low-voltage installations in which the rated supply voltage does not exceed 1,000 VAC (50/60 Hz) or 1,500 VDC.
Qualified project planning and design, proper transport, storage, installation, use and careful maintenance are essential to the flawless and safe operation of the automation system.
The automation system may only be used within the scope of the data and applications specified in the present documentation and associated user manuals.

The automation system is to be used only as follows

- → as prescribed,
- → in technically flawless condition,
- → without arbitrary or unauthorized changes and
- → exclusively by qualified users

The regulations of the German professional and trade associations, the German technical supervisory board (TÜV), the VDE (Association of German electricians) or other corresponding national bodies are to be observed.

Safety-oriented (fail-safe) systems
Particular measures are required in connection with the use of PLCs in safety-oriented systems. If a PLC is to be used in a safety-oriented system, the user ought to seek the full advice of the PLC manufacturer in addition to observing any standards or guidelines on safety installations which may be available.

⚠ WARNING	**As with any electronic control system, the failure of particular components may result in uncontrolled and/or unpredictable operation.** All types of failure and the associated fuse systems are to be taken into account at system level. The advice of the PLC manufacturer should be sought if necessary.

2. Introduction EtherCAT I/O Modules

2.1. EtherCAT - Ethernet Control Automation Technology

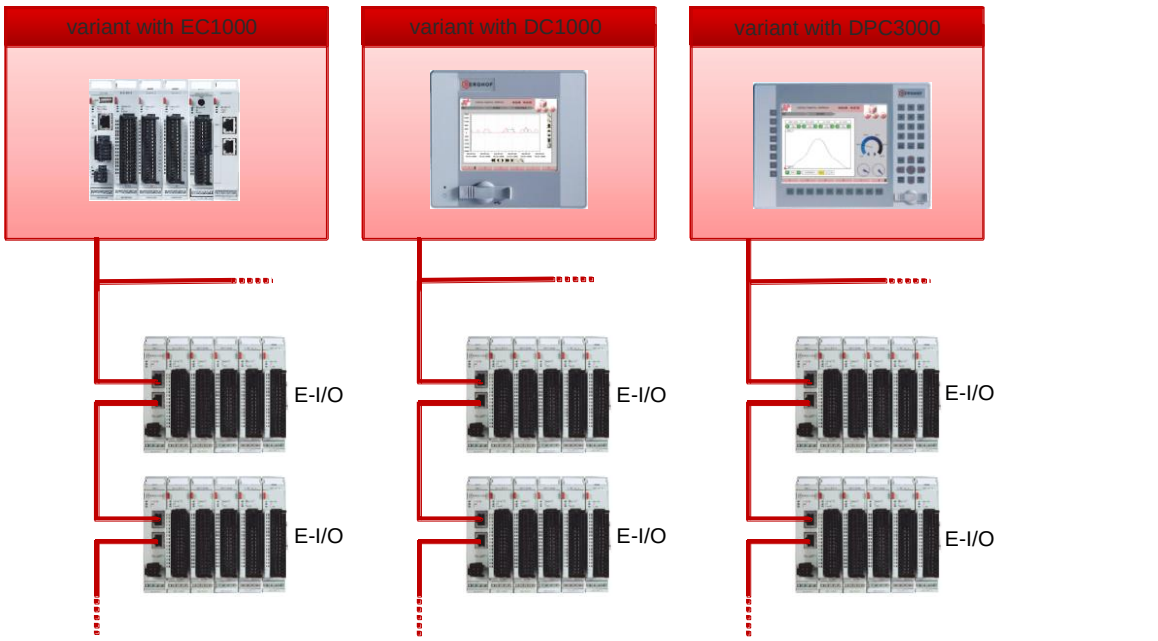
EtherCAT is one of the most powerful Ethernet-based fieldbus systems. EtherCAT puts up the top speed mark, and its flexible topology and simple configuration make it the perfect means of controlling extremely fast processes.
Because of its high performance, the simple wiring and its open protocol support, EtherCAT is often used as a fast motion control and I/O bus driven by an industrial PC or in conjunction with control technology on a smaller scale. EtherCAT moves beyond the limits of conventional fieldbus systems. Its interconnections between the controller at one end and both the I/O modules and drives at the other are as fast as those of a backplane bus. EtherCAT controllers thus nearly act like centralized control systems, overcoming the issue of bus transfer times that conventional fieldbus systems are burdened with.

2.2. CANtrol - the automation platform

The automation platform CANtrol EC and CANtrol Dialog has been specifically engineered with applications near to the machine in mind. CANtrol provides flexible automation solutions including hardware and software PLCs based around industrial PCs, remote I/Os, PLCs with / without display and decentralized drives. EtherCAT, PROFINET, Bacnet, PROFIBUS-DP and CANopen are supported for networking. CANtrol controllers and industrial PCs used as EtherCAT masters feature a CoDeSys PLC.

2.3. E-I/O - CANtrol EtherCAT I/O-System

CANtrol E-I/O is a system of I/O modules for connecting the process signals to an EtherCAT network. CANtrol E-I/O consists of the E-I/O bus coupler and a range of I/O modules.
The CANtrol E-I/O bus coupler converts the physical transfer technology (twisted pair) to LVDS (E-bus) and generates the system voltages required by the LVDS modules. The standard 100 Base Tx lines used for office network communications connect to the one side, the CANtrol E-I/O Modules for the process signals connect to the other. This is how the Ethernet EtherCAT protocol is retained right through to the last I/O module. At the end of the modular device, the connection between the forward and return lines is automatically closed, the effect being that another 100 Base Tx line can be plugged in to connect the next EtherCAT unit to the second bus coupler port.



2VF100530DG00.cdr

2.4. Electromagnetic compatibility

2.4.1. Definition

Electromagnetic compatibility is the ability of a device to function satisfactorily in its electromagnetic environment without itself causing any electromagnetic interference that would be intolerable to other devices in this environment.
Of all known phenomena of electromagnetic noise, only a certain range occurs at the location of a given device. It is defined in the relevant product standards.
The design and immunity to interference of programmable logic controllers are internationally governed by Standard IEC 61131-2 which, in Europe, has been the basis for European Standard EN 61131-2.

NOTICE	Refer to IEC 61131-4, User's Guideline, for general installation instructions to be complied with to ensure that hardware interface factors and the ensuing noise voltages are limited to tolerable levels.

2.4.2. Interference emission

Interfering emission of electromagnetic fields, HF compliant to EN 55011, limiting value class A, Group 1

NOTICE	If the controller is designed for use in residential areas, high-frequency emissions must comply with limiting value class B as described in EN 55011. Fitting the controller into earthed metal cabinets and in-stalling filters in the supply lines may produce a shielding compliant to the above standard.

2.4.3. General notes on installation

As component parts of machines, facilities and systems, electronic control systems must comply with valid rules and regulations, depending on their field of application.
General requirements concerning the electrical equipment of machines and aiming at the safety of these machines are contained in Part 1 of European Standard EN 60204 (same as VDE 0113).

For safe installation of our control system please observe the information given below.

2.4.4. Electrical immission safeguard

Connect the control system to the protective earth conductor to eliminate electromagnetic interference.
Practice best cable routing.

2.4.5. Cable routing and wiring

Keep power circuits separate from control circuits:
→ DC voltages 60 V ... 400 V
→ AC voltages 25 V ... 400 V

Joint laying of control circuits is allowed for:
→ shielded data signals
→ shielded analogue signals
→ unshielded digital I/O lines
→ unshielded DC voltages < 60 V
→ unshielded AC voltages < 25 V

2.4.6. Location of installation

Exclude any and all impediments due to temperature, dirt, impact, vibration or electromagnetic interference.

Temperature
Consider heat sources such as general heating of rooms, sunlight, heat accumulation in assembly rooms or control cabinets.

Contamination
Use suitable casings to avoid possible negative influences due to humidity, corrosive gas, liquid or conducting dust.

Impact and vibration
Consider possible influences caused by motors, compressors, transfer lines, presses, ramming machines and vehicles.

Electromagnetic interference
Consider electromagnetic interference from various local sources: motors, switching devices, switching thyristors, radio-controlled devices, welding equipment, arcing, switched-mode power supplies, converters / inverters.

2.4.7. Particular sources of interference

Inductive actuators
Switching off inductances (such as from relays, contactors, solenoids or switching magnets) produces surge voltages. It is necessary to reduce these extra voltages to a minimum. Reducing elements may be diodes, Z-diodes, varistors or RC elements. To find the best adapted elements, we recommend that you contact the manufacturer or supplier of the corresponding actuators for the relevant information.

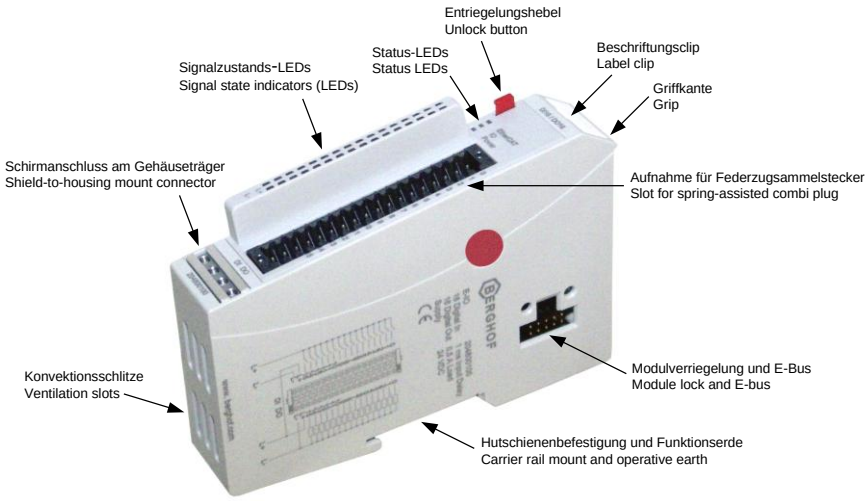
3. System description EtherCAT I/O Modules

CANtrol E-I/O is a system of I/O modules for connecting the process signals to any EtherCAT network station.
CANtrol E-I/O consists of the CANtrol E-I/O bus coupler and a range of CANtrol E-I/O modules.
The CANtrol E-I/O bus coupler converts the physical transfer technology (twisted pair) to LVDS (E-bus) and generates the system voltages required by the LVDS modules. The standard 100 Base Tx lines used for office network communications connect to the one side, the CANtrol E-I/O modules for the process signals connect to the other. This is how the Ethernet EtherCAT protocol is retained right through to the last I/O module. At the end of the modular device, the connection between the forward and return lines is automatically closed, the effect being that another 100 Base Tx line can be plugged in to connect the next EtherCAT unit to the second bus coupler port.
If the bus coupler is the last station of the EtherCAT network, i.e. if its RJ45 "Out" socket remains unplugged, the connection between the forward and return lines is automatically closed.

3.1. Mechanical design

The figure shows the basic layout of the CANtrol E-I/O modules.
The bus coupler and the I/O modules differ in their connectors and indicators, however.

Module structure



2VF100534DG00.VSD

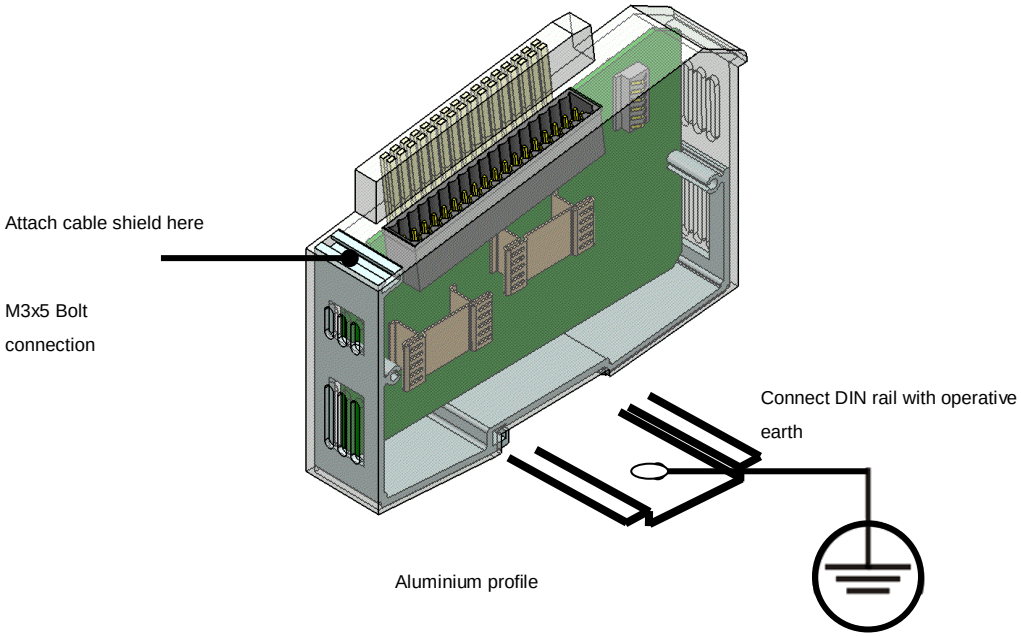
The housing mount consists of an aluminium profile with an integral snap-on device used to snap the module to a 35mm DIN rail.
The housing trough including the optical fibres for the status indicators, the side face and the front is made of plastic and contains the module.
The optical fibres for the signal state indicators (LEDs) are located next to the spring-assisted combi plug. They slightly protrude from the housing and allow a clear diagnosis at a glance.

3.1.1. Earth

The CANtrol E-I/O modules shall be earthed. Thereto the metal housing shall be attached to operative earth. Since the operative earth connectors dissipate HF currents, it is of utmost importance for the module's noise immunity.
HF interference is dissipated from the electronics board to the metal housing. The metal housing therefore needs to be suitably connected to an operative earth connector.
You will normally have to ensure that

→ the connection between module housing and DIN rail conducts well,
→ the connection between DIN rail and switching cabinet conducts well,
→ the switching cabinet is safely connected to earth.

In special cases you may attach the earth wire straight to the module.



NOTICE

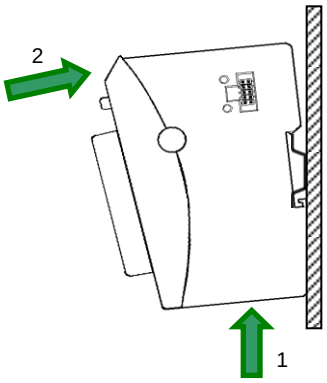
Earth wires should be short and have a large surface (copper mesh).
Further details has site http://en.wikipedia.org/wiki/Ground_(electricity)

3.1.2. Installation

The CANtrol E-I/O modules are intended for mounting rail installation (DIN EN 50022, 35 x 7.5 mm).

→ Push up the module against the mounting rail from below, allowing the metal spring to snap in between mounting rail and mounting area as illustrated.
→ Push the module above against the mounting wall until it snaps in.

→ To snap on a single module



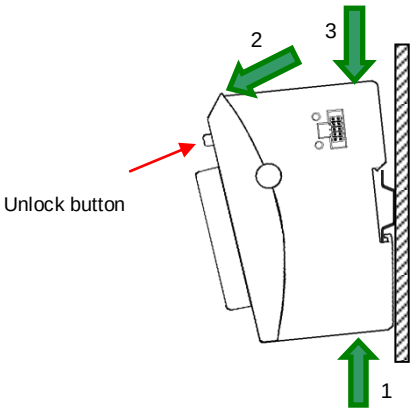
Rail mounting of module

To interconnect two modules
After snapping on the first module to the rail, snap on the second module about 1cm away towards the right of the first module. Push the second module along the rail towards the first module until you hear the locking device snap in.

To disconnect two modules
Push down the unlock button (see figure below) of the module that you wish to disconnect from the module to the left of it. Push both modules away from one another until they are about 1 cm apart.

→ Push the module up and against the metal spring located on the underside of the rail guide.
→ Tip the module away from the rail as shown in the illustration.
→ Pull the module down and out of the mounting rail.

→ To take down a single module



Uninstalling a module

3.2. System power supply

3.2.1. General

General Spring-assisted blocks of sockets allow fast and simple wiring. A multiple socket connector densely packs the wires on a small footprint. Use the unlock button to easily disconnect the wires where there is little space.

Tool: 0.4 x 2.5 blade screwdriver
Cores: 0.20 - 1.0 mm² (IEC) / 28 - 18 ENC (UL)
Rated current: 5 A (CSA) / 10 A (UL)

⚠ CAUTION

Do not connect the power supply lines through from one I/O power supply port to the next.

To ensure that there is as little interference as possible, install a central power supply point and establish a star topology of as short wires as possible between the central point and the I/O Modules.

3.2.2. Bus coupler

The system power supply connects to the bus coupler through a 2-pole plug-type terminal block. Since the bus coupler supplies power to both the E-bus and the logic circuits of the I/O modules, its power consumption depends on the number of I/O modules connected.
Power to the I/O module outputs is supplied separately.

Spring-assisted connector and bus coupler unlock button
2VF100532DG00.cdr

3.2.3. I/O Modules

The I/O supply connects to the I/O module, normally together with the I/Os, using plug-type terminal blocks with different numbers of poles.
Power to the I/O module logic circuits is supplied by the bus coupler.

Spring-assisted connector with I/O module unlock button
2VF100533DG00.cdr

3.3. Status LEDs

3.3.1. “EtherCAT” LED

An LED labeled “EtherCAT” is located on both the bus coupler and the I/O Modules. It indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

3.3.2. “In” LED, “Out” LED

The “In” and “Out” LEDs are located on the bus coupler. They indicate the respective physical state of the Ethernet.

Ethernet		
State	**LED flash code**	**Explanation**
Not connected	Off	No Ethernet connection
Connected	Green, on	Connected to Ethernet
Traffic	Green, flashing	Exchanging telegrams

3.3.3. “I/O” LED

Every I/O Module has an LED labeled "IO". It indicates the state of the Module's I/Os. Refer to the I/O Module sections in this manual to know which states of a module are monitored and indicated.

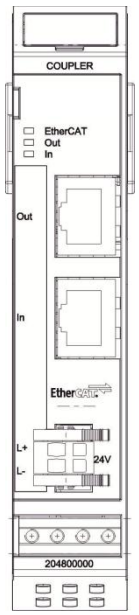
3.3.4. “Power” LED

An LED labeled “Power” is located on every I/O Module that has a power supply connector (e.g. for digital outputs). It indicates the state of the I/O module's I/O power supply.

I/O power supply		
State	**LED flash code**	**Explanation**
On	Green, on	24 V DC supply ok
Off	Off	24 V DC supply not ok

Blank page

4. Bus coupler



Bus coupler front view

4.1. Terminals

Module power supply
L+: 24 V DC
L-: 0 V

EtherCAT (RJ45 socket)
IN: input (from previous EtherCAT station)
OUT: output (to next EtherCAT station)

4.2. Status LEDs

“EtherCAT” LED
The LED labeled “EtherCAT” indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

“In” LED, “Out” LED
The “In” and “Out” LEDs indicate the physical state of the Ethernet’s ports they are allocated to.

Ethernet		
State	**LED flash code**	**Explanation**
Not connected	Off	No Ethernet connection
Connected	Green, on	Connected to Ethernet
Traffic	Green, flashing	Exchanging telegrams

4.3. Function

The CANtrol E-I/O bus coupler converts the physical transfer technology (twisted pair) to LVDS (E-bus) and generates the system voltages required by the LVDS modules.
The standard 100 Base Tx lines used for office network communications connect to the one side, the CANtrol E-I/O Modules for the process signals connect to the other. This is how the Ethernet EtherCAT protocol is retained right through to the last I/O module.
At the end of the modular device, the connection between the forward and return lines is automatically closed, the effect being that another 100 Base Tx line can be plugged in to connect the next EtherCAT unit to the second bus coupler port.

Module state		
Variable	**Data type**	**Explanation**
Undervoltage	BOOL	Low voltage (supplied power < 19.2 V)

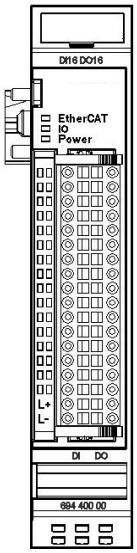
4.4. Technical data

Bus coupler	
Label	E-I/O BUSKOPPLER 3A
Part no.	204800000
Plug-in connector	2-pole 204801800 (part of the package)
Function	Connects a 100Base-TX EtherCAT with the CANtrol E-I/O Modules Generates the LVDS system voltages
Controller	ASIC ET1100
Baud rate	100Mbit/s
Cable	CAT5
Length of cable	max. 100 m between 2 bus couplers
Terminal EtherCAT	2 x RJ45
Power supply	24 V DC -20% +25%
Connector power	Plug 2-pole (part of the module)
Input current	50 mA + E-bus power supply
E-bus power supply	max. 3 A (ca. 20 modules)
E-bus load	195 mA

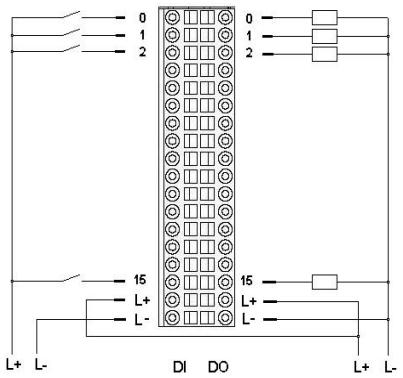
Blank page

5. Digital modules

5.1. Digital in- and outputs DI16 / DO16



Front view of DI16/DO16 I/O module



I/O connection

5.1.1. Terminals

Power supply to module I/Os
L+: 24 V DC
L-: 0 V

CAUTION	Connect L+ to both L+ terminals if the total current exceeds the 6A limit.

5.1.2. Status LEDs

"EtherCAT" LED
The LED labeled "EtherCAT" indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

“I/O” LED
The LED labeled “IO” indicates the state of the module's I/Os.

I/O		
State	**LED flash code**	**Explanation**
Ok	Off	No error
SC	Red, on	Short-circuited digital output

⚠ CAUTION

The output drivers have a thermal fuse to automatically turn off any short-circuited outputs.
In case the short circuit prevails, the outputs are allowed to cool down to be turned back on until the thermal fuse blows again.

“Power” LED
The LED labeled "Power" indicates the state of the I/O module's I/O power supply.

Power		
State	**LED flash code**	**Explanation**
On	Green, on	24 V DC supply ok
Off	Off	24 V DC supply not ok

⚠ CAUTION

The module is not monitored for low voltage states.

“Channel” LEDs

Channel		
State	**LED**	**Explanation**
On	Green, on	Input signal TRUE / output enabled
Off	Off	Input signal FALSE / output disabled

5.1.3. Function

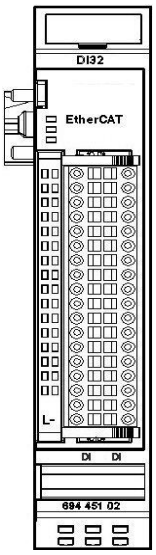
The DI16/DO16 module features 16 digital inputs and 16 digital outputs.

Function		
Variable	**Data type**	**Explanation**
DigitalInputn	BOOL	Digital input (n=0…15)
DigitalOutputn	BOOL	Digital output (n=0…15)

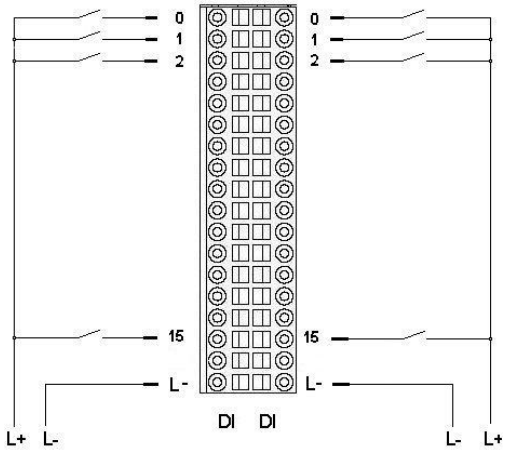
5.1.4. Technical data

DI16 / DO16	
Label	E-I/O DI16/DO16 1MS/0.5A
Part no.	204800100
Plug-in connector	36-pole 204800300 (not part of the module)
Digital inputs	16
Input delay	1 ms / 5 ms (typically)
Signal level	Off: -3 … 5 V (EN 61131-3, Type1) On: 15 V … 30 V
Digital outputs	16
Max. current	0.5 A per output
Total current	max. 8 A
Controller	ASIC ET1200
Baud rate	100 Mbit/s
Connector	10-pin system plug in side wall
Term. module	not required
Power supply	24 V DC -20% +25%
E-bus load	135 mA

5.2. Digital inputs DI32



Front view of DI32 I/O module



I/O connection

5.2.1. Terminals

Power supply to module I/Os
L-: 0 V

5.2.2. Status LEDs

"EtherCAT" LED
The LED labeled "EtherCAT" indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

"I/O" LED
There is no LED labeled "I/O".

"Power" LED
There is no LED labeled "Power" because a separate power feed is not required.

“Channel” LEDs

Channel		
State	**LED**	**Explanation**
On	Green, on	Input signal TRUE
Off	Off	Input signal FALSE

5.2.3. Function

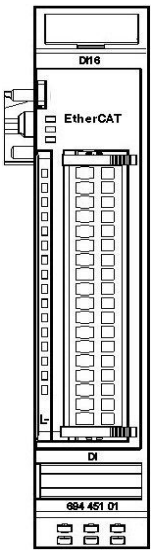
The DI32 module has 32 digital inputs.

Function		
Variable	**Data type**	**Explanation**
DigitalInputn	BOOL	Digital input (n=0…31)

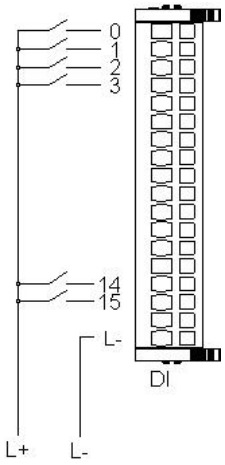
5.2.4. Technical data

DI32	
Label	E-I/O DI32 1MS
Part no.	204800900
Plug-in connector	36-pole 204800300 (not part of the module)
Digital inputs	32
Input delay	1 ms / 5 ms (typically)
Signal level	Off: -3 … 5 V (EN 61131-3, Type1) On: 15 V … 30 V
Controller	ASIC ET1100
Baud rate	100 Mbit/s
Connector	10-pin system plug in side wall
Term. module	not required
Power supply	24 V DC -20 % +25 %
E-bus load	85 mA

5.3. Digital inputs DI16



Front view of DI16 I/O module



I/O connection

5.3.1. Terminals

Power supply to module I/Os
L-: 0 V

5.3.2. Status LEDs

"EtherCAT" LED
The LED labeled "EtherCAT" indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

"I/O" LED
There is no LED labeled "I/O".

"Power" LED
There is no LED labeled "Power" because a separate power feed is not required.

“Channel” LEDs

Channel		
State	**LED**	**Explanation**
On	Green, on	Input signal TRUE
Off	Off	Input signal FALSE

5.3.3. Function

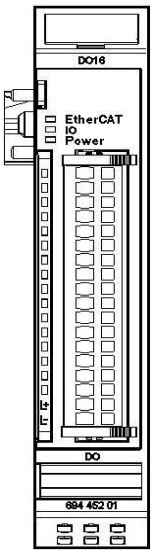
The DI16 module has 16 digital inputs.

Function		
Variable	**Data type**	**Explanation**
DigitalInputn	BOOL	Digital input (n=0…15)

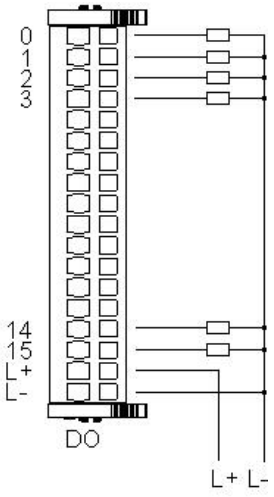
5.3.4. Technical data

DI16	
Label	E-I/O DI16 1MS
Part no.	204800800
Plug-in connector	18-pole 204800400 (not part of the module)
Digital inputs	16
Input delay	1 ms / 5 ms (typically)
Signal level	Off: -3 … 5 V (EN 61131-3, Type1) On: 15 V … 30 V
Controller	ASIC ET1200
Baud rate	100 Mbit/s
Connector	10-pin system plug in side wall
Term. module	not required
Power supply	24 V DC -20% +25%
E-bus load	100 mA

5.4. Digital outputs DO16



Front view of the DO16 I/O module



I/O connection

5.4.1. Terminals

Power supply to module I/Os
L+: 24 V DC
L-: 0 V

5.4.2. Status LEDs

"EtherCAT" LED
The LED labeled "EtherCAT" indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

“I/O” LED
The LED labeled “I/O” indicates the state of the module’s I/Os.

I/O		
State	**LED flash code**	**Explanation**
Ok	Off	No error
SC	Red, on	Short-circuited digital output

CAUTION

The output drivers have a thermal fuse to automatically turn off any short-circuited outputs.
In case the short circuit prevails, the outputs are allowed to cool down to be turned back on until the thermal fuse blows again.

“Power” LED
The LED labeled "Power" indicates the state of the I/O module's I/O power supply.

Power		
State	**LED flash code**	**Explanation**
On	Green, on	24 V DC supply ok
Off	Off	24 V DC supply not ok

CAUTION

The module is not monitored for low voltage states.

“Channel” LEDs

Channel		
State	**LED**	**Explanation**
On	Green, on	Output enabled
Off	Off	Output disabled

5.4.3. Function

The DO16 module has 16 digital outputs.

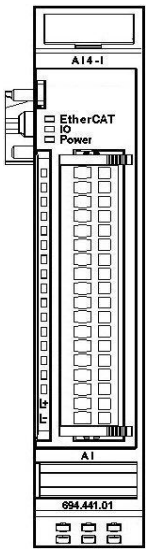
Function		
Variable	**Data type**	**Explanation**
DigitalOutputn	BOOL	Digital output (n=0…15)

5.4.4. Technical data

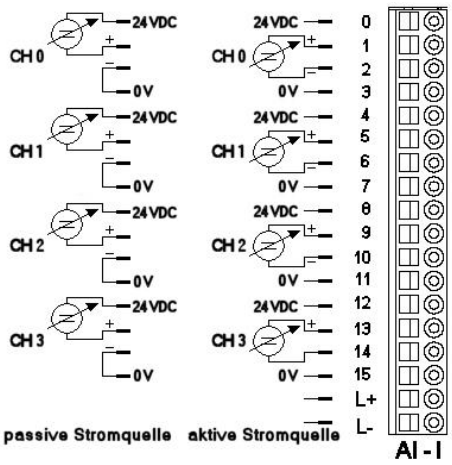
DO16	
Label	E-I/O DO16 0,5A
Part no.	204801000
Plug-in connector	18-pole 204800400 (not part of the module)
Digital outputs	16
Max. current	0,5 A per output
Total current	max. 8 A
Controller	ASIC ET1200
Baud rate	100 Mbit/s
Connector	10-pin system plug in side wall
Term. module	not required
Power supply	24 V DC -20% +25%
E-bus load	130 mA

6. Analogue modules

6.1. Analogue inputs for current measurement AI4-I



Front view of AI4-I I/O module



I/O connection passive/active power source

6.1.1. Terminals

Module supply
L+: 24 V DC
L-: 0 V
Operative earth / shielding of analog wires → section **3.1.1** Earth

6.1.2. Status LEDs

"EtherCAT" LED
The LED labeled "EtherCAT" indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

“I/O” LED
The LED labeled “I/O” indicates the state of the module's I/Os.

I/O		
State	**LED flash code**	**Explanation**
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 2x	Undervoltage (not implemented)
	Red, 3x	Watchdog
	Red, 4x	EtherCAT watchdog control
	Red, 6x	Module-specific fault
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

“Power” LED
The LED labeled "Power" indicates the state of the I/O module's I/O power supply.

Power		
State	**LED flash code**	**Explanation**
On	Green, on	24 V DC supply ok
Off	Off	24 V DC supply not ok

“Channel” LEDs

Channel		
State	**LED flash code**	**Explanation**
On	Green, on	Channel enabled
Off	Off	Channel disabled
Error	Red	Open, overcurrent

6.1.3. Function

The AI4-I module has 4 analogue current signal inputs. Their measuring range can be set separately for every channel, i.e. either to 0..20 mA or to 4..20 mA.

Analogue inputs

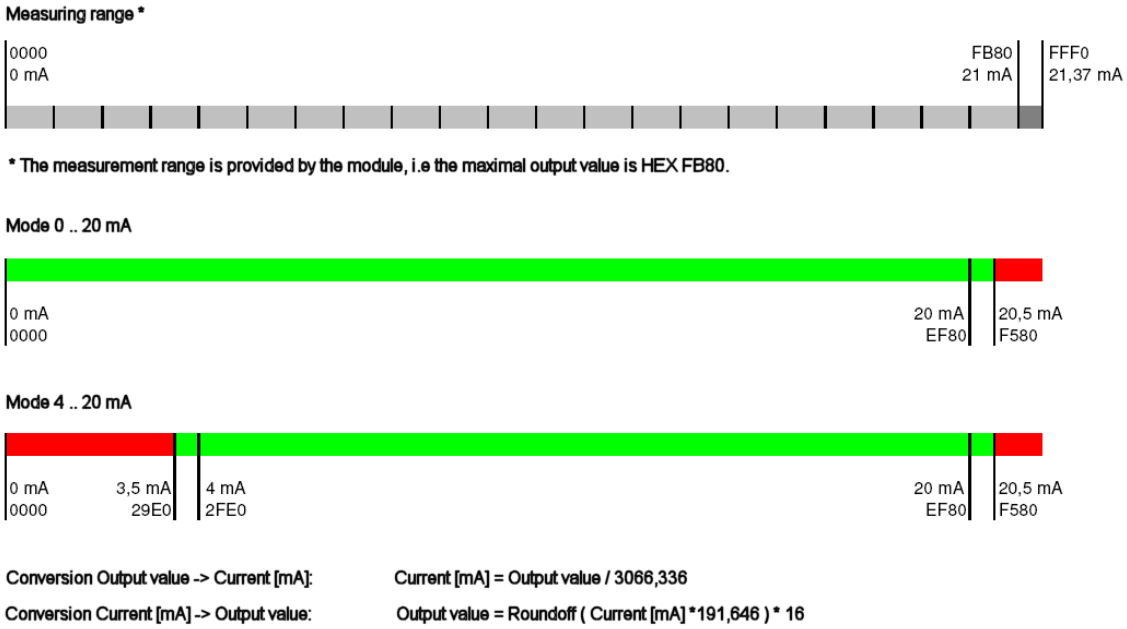
Check the following variable for the digitized input values:

Inputs		
Variable	**Data type**	**Explanation**
Channel_n	INT	Value measured on channel n (n= 0…3)

Measured value

The maximal measuring value (0xFFF0) of the current input module is 0.5 V/23.4 Ω = 21.3675 mA.
The status is shown by the channel LED.

Measuring values, variable values and status



Analogue values current

Measuring	Variable value		
mA	**decimal**	**CODESYS (INT)**	**hexadecimal**
0	0	0	0
1	3056	3056	16#0BF0
2	6128	6128	16#17F0
3	9184	9184	16#23E0
4	12256	12256	16#2FE0
5	15328	15328	16#3BE0
6	18384	18384	16#47D0
7	21456	21456	16#53D0
8	24528	24528	16#5FD0
9	27584	27584	16#6BC0
10	30656	30656	16#77C0
11	33728	-31808	16#83C0
12	36784	-28752	16#8FB0
13	39856	-25680	16#9BB0
14	42928	-22608	16#A7B0
15	45984	-19552	16#B3A0
16	49056	-16480	16#BFA0
17	52112	-13424	16#CB90
18	55184	-10352	16#D790
19	58256	-7280	16#E390
20	61312	-4224	16#EF80
20.5	62848	-2688	16#F580
…			
≥ 21.37	65520	-16	16#FFF0

Module control
The module provides you with various operational options.
To set up the module choose the options as appropriate and accept by setting control bit “SetOptions” to a rising edge. The module will confirm by returning “OptionsSet”.

There are various “module error” bits that the module uses to indicate errors. The states of the error bits are retained and also used for error indication by the “I/O” LED. To reset the error bits set control bit “ResetError” to a rising edge.

Error bits		
Variable	**Data type**	**Explanation**
SetOptions	BOOL	Rising edge → accepts module options
ResetError	BOOL	Rising edge → acknowledges error

Module options
The following options are available for module AI4-I:

Module options			
Variable	**Data type**		**Explanation**
Channel_n_0_20mA	BOOL	TRUE	Channel n to 0…20 mA
		FALSE	Channel n to 4…20 mA
Channel_n_On	BOOL		Enables channel n
Channel_n_Filter	USINT	0..255	Filter on channel n New values avail. in k/3 ms (k=0..255)
n		0 … 3	Channel number

To set and accept options, see Module control

Module state
The following states are indicated:

Module state		
Variable	**Data type**	**Explanation**
Shortcut	BOOL	Short circuit
Undervoltage	BOOL	Low voltage (supplied power < 19.2 V)
Watchdog	BOOL	Internal watchdog of module
EtherCAT_Error	BOOL	Configuration error or watchdog control
Specific_Error	BOOL	Module-specific fault
OptionsSet	BOOL	Sent by module to acknowledge SetOptions

To reset the messages, see Module control

Module-specific messages
Apart from the module error messages, there is a set of messages containing details about the current state of the module:

Messages		
Variable	**Data type**	**Explanation**
Channel_n_Open	BOOL	4..20 mA mode: input current < 3.5 mA → Specific_Error = TRUE
Channel_n_Overcurrent	BOOL	Input current > 20.5 mA → Specific_Error = TRUE

These messages are automatically reset when the state concerned has returned to normal.

Conversion time
The analogue signals are converted one by one down every channel. Disabling one or several channels will shorten the entire A/D conversion cycle.
"Filter" in this case means to compute an average when the set filter time is over.
Analogue value conversion runs cyclically and is not synchronized with the receipt of EtherCAT telegrams.
The cycle consists of the analogue value conversion plus transmitting the values into the EtherCAT data area.

Channel	
Number of channels	**Cycle time in ms (all filters=0)**
1	0.27
2	0.41
3	0.55
4	0.69

NOTICE

If you are aiming for a high sampling frequency, the EtherCAT master should do the filtering (averaging) because it will normally have much more processing power.

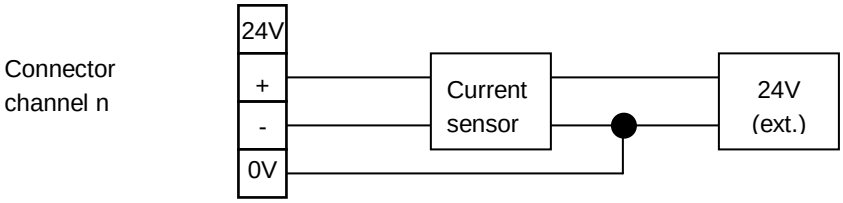
NOTICE

Take the EtherCAT cycle into account to assess how much the values stored by the EtherCAT master are up-to-date. The module described in this section will accept the above times as the ideal EtherCAT cycle setup.

Quality of analogue values
The inputs connect to both active or passive current sensors.
The module provides terminals for the 24 V DC- supply to the transmitter of every channel.

Passive current sensors:
Interconnect the "–" and "0 V" terminals.

Active current sensors:
Use the power supplied by the module if at all possible.
If power to the current sensors is supplied by an external source, connect the 0 V terminal of that power source to the 0 V terminal of the module.



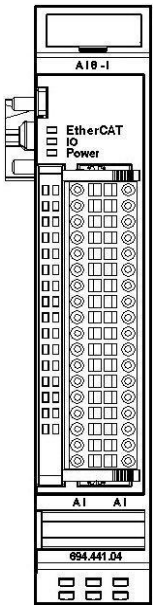
NOTICE

Best results are obtained by connected the shield of the signal cables to operative earth.

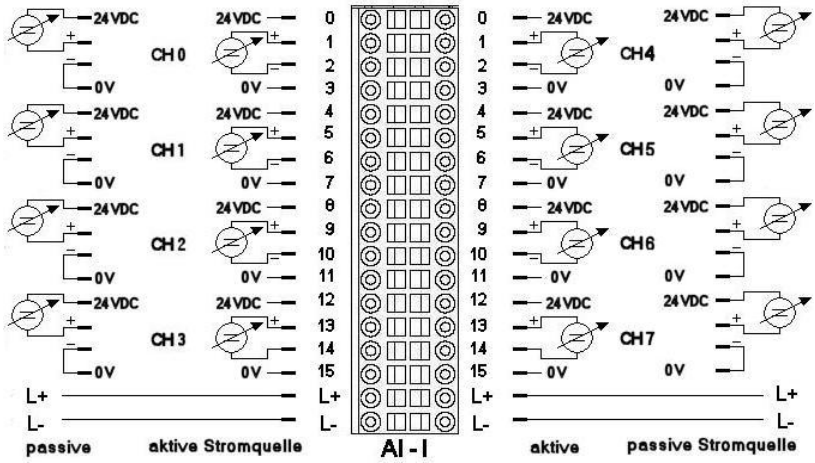
6.1.4. Technical data

AI4-I	
Label	E-I/O AI4-I 12BIT
Part no.	204801100
Plug-in connector	18-pole 204800400 (not part of the module)
Analogue inputs	4 single ended
Resolution	12 Bit (5.2 µA)
Measuring range	0 … 20 mA, 4..20 mA (limit 21.3675 mA)
Temperature drift	< ± 25 ppm/°C regarding range limit
Critical frequency	typical 12.5 kHz
Burden	< 75 Ω
Sampling frequency	1.45 kHz (if all channels are enabled)
Controller	ASIC ET1200
Baud rate	100 Mbit/s
E-bus port	10-pin system plug in side wall
Term. module	not required
Power supply	from coupler through E-bus connector
E-bus load	140 mA

6.2. Analogue inputs for current measurement AI8-I



Front view of AI8-I I/O module



I/O connection passive/active power source

6.2.1. Terminals

Module supply
L+: 24 V DC
L-: 0 V
Operative earth / shielding of analog wires → section **3.1.1** Earth

6.2.2. Status LEDs

"EtherCAT" LED
The LED labeled "EtherCAT" indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

“I/O” LED
The LED labeled “I/O” indicates the state of the module's I/Os.

I/O		
State	**LED flash code**	**Explanation**
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 2x	Undervoltage (not implemented)
	Red, 3x	Watchdog
	Red, 4x	EtherCAT watchdog control
	Red, 6x	Module-specific fault
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

“Power” LED
The LED labeled "Power" indicates the state of the I/O module's I/O power supply.

Power		
State	**LED flash code**	**Explanation**
On	Green, on	24 V DC supply ok
Off	Off	24 V DC supply not ok

“Channel” LEDs

Channel		
State	**LED flash code**	**Explanation**
On	Green, on	Channel enabled
Off	Off	Channel disabled
Error	Red	Open, overcurrent

6.2.3. Function

The AI8-I module has 8 analogue current signal inputs. Their measuring range can be set separately for every channel, i.e. either to 0..20 mA or to 4..20 mA.

Analogue inputs

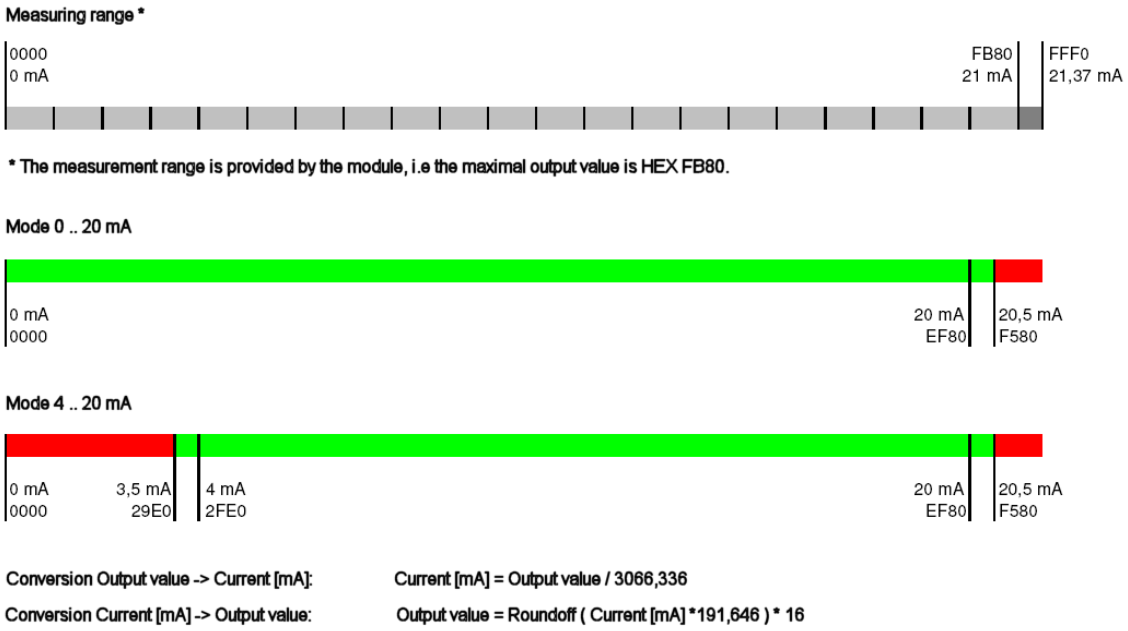
Check the following variable for the digitized input values:

Inputs		
Variable	**Data type**	**Explanation**
Channel_n	INT	Value measured on channel n (n= 0…7)

Measured value

The maximal measuring value (0xFFF0) of the current input module is 0.5 V/23.4 Ω = 21.3675 mA.
The status is shown by the channel LED.

Measuring values, variable values and status



Analogue values current

Measuring	Variable value		
mA	**decimal**	**CODESYS (INT)**	**hexadecimal**
0	0	0	0
1	3056	3056	16#0BF0
2	6128	6128	16#17F0
3	9184	9184	16#23E0
4	12256	12256	16#2FE0
5	15328	15328	16#3BE0
6	18384	18384	16#47D0
7	21456	21456	16#53D0
8	24528	24528	16#5FD0
9	27584	27584	16#6BC0
10	30656	30656	16#77C0
11	33728	-31808	16#83C0
12	36784	-28752	16#8FB0
13	39856	-25680	16#9BB0
14	42928	-22608	16#A7B0
15	45984	-19552	16#B3A0
16	49056	-16480	16#BFA0
17	52112	-13424	16#CB90
18	55184	-10352	16#D790
19	58256	-7280	16#E390
20	61312	-4224	16#EF80
20.5	62848	-2688	16#F580
…			
≥ 21.37	65520	-16	16#FFF0

Module control
The module provides you with various operational options.
To set up the module choose the options as appropriate and accept by setting control bit “SetOptions” to a rising edge. The module will confirm by returning “OptionsSet”.

There are various “module error” bits that the module uses to indicate errors. The states of the error bits are retained and also used for error indication by the “I/O” LED. To reset the error bits set control bit “ResetError” to a rising edge.

Error bits		
Variable	**Data type**	**Explanation**
SetOptions	BOOL	Rising edge → accepts module options
ResetError	BOOL	Rising edge → acknowledges error

Module options
The following options are available for module AI8-I:

Module options			
Variable	**Data type**		**Explanation**
Channel_n_0_20mA	BOOL	TRUE	Channel n to 0…20 mA
		FALSE	Channel n to 4…20 mA
Channel_n_On	BOOL		Enables channel n
Channel_n_Filter	USINT	0..255	Filter on channel n New values avail. in k/3 ms (k=0..255)
n		0 … 7	Channel number

To set and accept options, see Module control

Module state
The following states are indicated:

Module state		
Variable	**Data type**	**Explanation**
Shortcut	BOOL	Short circuit
Undervoltage	BOOL	Low voltage (supplied power < 19.2 V)
Watchdog	BOOL	Internal watchdog of module
EtherCAT_Error	BOOL	Configuration error or watchdog control
Specific_Error	BOOL	Module-specific fault
OptionsSet	BOOL	Sent by module to acknowledge SetOptions

To reset the messages, see Module control

Module-specific messages
Apart from the module error messages, there is a set of messages containing details about the current state of the module:

Messages		
Variable	**Data type**	**Explanation**
Channel_n_Open	BOOL	4..20 mA mode: input current < 3.5 mA → Specific_Error = TRUE
Channel_n_Overcurrent	BOOL	Input current > 20.5 mA → Specific_Error = TRUE

These messages are automatically reset when the state concerned has returned to normal.

Conversion time
The analogue signals are converted one by one down every channel. Disabling one or several channels will shorten the entire A/D conversion cycle.
“Filter” in this case means to compute an average when the set filter time is over.
Analogue value conversion runs cyclically and is not synchronized with the receipt of EtherCAT telegrams.
The cycle consists of the analogue value conversion plus transmitting the values into the EtherCAT data area.

Conversion time			
Number of channels	**Cycle time in ms**	**Number of channels**	**Cycle time in ms**
1	0.40	5	0.92
2	0.53	6	1.06
3	0.66	7	1.19
4	0.79	8	1.32

NOTICE

If you are aiming for a high sampling frequency, the EtherCAT master should do the filtering (averaging) because it will normally have much more processing power.

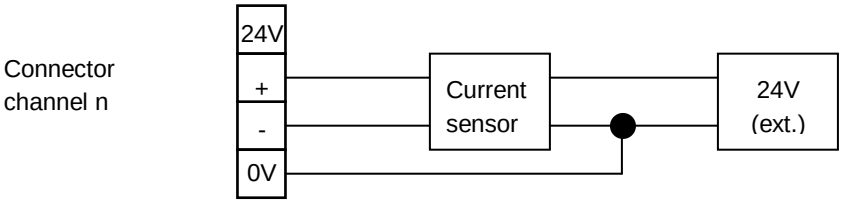
NOTICE

Take the EtherCAT cycle into account to assess how much the values stored by the EtherCAT master are up-to-date. The module described in this section will accept the above times as the ideal EtherCAT cycle setup.

Quality of analogue values
The inputs connect to both active or passive current sensors.
The module provides terminals for the 24 V DC- supply to the transmitter of every channel.

Passive current sensors:
Interconnect the "–" and "0 V" terminals.

Active current sensors:
Use the power supplied by the module if at all possible.
If power to the current sensors is supplied by an external source, connect the 0 V terminal of that power source to the 0 V terminal of the module.



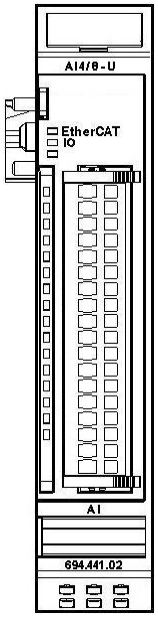
NOTICE

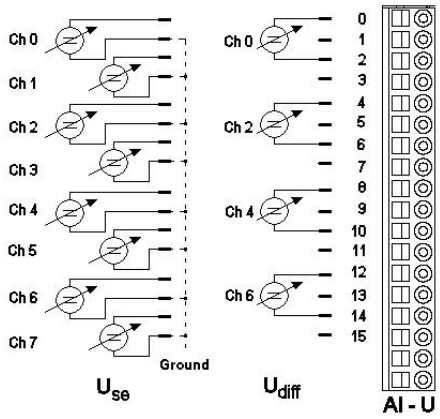
Best results are obtained by connected the shield of the signal cables to operative earth.

6.2.4. Technical data

AI8-I	
Label	E-I/O AI8-I 12 BIT
Part no.	204802700
Plug-in connector	18-pole 204800400 (not part of the module)
Analogue inputs	8 single ended
Resolution	12 Bit (5.2 µA)
Measuring range	0 … 20 mA, 4..20 mA (limit 21.3675 mA)
Temperature drift	< ± 25 ppm/°C regarding range limit
Critical frequency	typical 12.5 kHz
Burden	< 75 Ω
Sampling frequency	0.76 kHz (if all channels are enabled)
Controller	ASIC ET1200
Baud rate	100 Mbit/s
E-bus port	10-pin system plug in side wall
Term. module	not required
Power supply	from coupler through E-bus connector
E-bus load	160 mA

6.3. Analogue inputs for voltage measurement AI4/8-U





Front view of AI4/8-U I/O module

I/O connection

6.3.1. Terminals

The module needs no separate 24 V connector. Power is supplied to the module through the E-bus connector.
Operative earth / shielding of analog wires → section **3.1.1** Earth

6.3.2. Status LEDs

"EtherCAT" LED
The LED labeled "EtherCAT" indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

“I/O” LED
The LED labeled “I/O” indicates the state of the module's I/Os.

I/O		
State	**LED flash code**	**Explanation**
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 3x	Watchdog
	Red, 4x	EtherCAT watchdog control
	Red, 6x	Module-specific fault
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

“Power” LED
There is no LED labeled “Power” because a separate power feed is not required.

“Channel” LEDs

Channel		
State	**LED flash code**	**Explanation**
On	Green, on	Channel enabled
Off	Off	Channel disabled

6.3.3. Function

The AI4/8-U module has 8 analogue inputs. If signal lines are single-ended (measured against earth, L-), 8 channels are available. To measure differential signals, you will need 2 channels for every signal, i.e. you can pick up no more than 4 differential signals. Channels can be combined as follows: 0/1, 2/3, 4/5 and 6/7.

Analogue inputs
Check the following variable for the digitized input values:

Inputs		
Variable	**Data type**	**Explanation**
Channel_n	INT	Value measured on channel n (n= 0…7)

Analogue values voltage

Measuring	Variable value (for 16 bit)					
	bipolar			unipolar		
volt	decimal	CODESYS (INT)	hexadecimal	decimal	CODESYS (INT)	hexadecimal
-10	32768	-32768	16#8000			
-9	36044	-29492	16#8CCC			
-8	39321	-26215	16#9999			
-7	42598	-22938	16#A666			
-6	45875	-19661	16#B333			
-5	49152	-16384	16#C000			
-4	52428	-13108	16#CCCC			
-3	55705	-9831	16#D999			
-2	58982	-6554	16#E666			
-1	62244	-3292	16#F324			
0	0	0	0	0	0	0
1	3276	3276	16#0CCC	6553	6553	16#1999
2	6553	6553	16#1999	13107	13107	16#3332
3	9830	9830	16#2666	19660	19660	16#4CCC
4	13106	13106	16#3332	26214	26214	16#6665
5	16383	16383	16#3FFF	32767	32767	16#7FFF
6	19660	19660	16#4CCC	39320	-26216	16#9998
7	22936	22936	16#5998	45874	-19662	16#B332
8	26213	26213	16#6665	52427	-13109	16#CCCB
9	29490	29490	16#7332	58981	-6555	16#E665
10	32767	32767	16#7FFF	65534	-2	16#FFFE

Module control
The module provides you with various operational options.
To set up the module choose the options as appropriate and accept by setting control bit “SetOptions” to a rising edge. The module will confirm by returning “OptionsSet”.

There are various “module error” bits that the module uses to indicate errors. The states of the error bits are retained and also used for error indication by the “I/O” LED. To reset the error bits set control bit “ResetError” to a rising edge.

Error bits		
Variable	**Data type**	**Explanation**
SetOptions	BOOL	Rising edge → accepts module options
ResetError	BOOL	Rising edge → acknowledges error

Module options
The following options are available for module AI4/8-U:

Module options		
Variable	**Data type**	**Explanation**
Channel_n_n+1_Differential	BOOL	The difference in voltages of channel n and channel n+1 is measured and output to channel n.
Channel_n_On	BOOL	Enable channel n
Channel_n_Unipolar	BOOL	Change measuring range of channel n from bipolar +10 V ... -10 V to unipolar 0… 10 V (doubles the resolution)
Channel_n_Filter	USINT	Filter on channel n New values avail. in k/3 ms (k=0..255)
n		0 … 7 Channel number

To set and accept options, see Module control

Module state
The following states are indicated:

Module state		
Variable	**Data type**	**Explanation**
Shortcut	BOOL	Not used
Undervoltage	BOOL	Not used
Watchdog	BOOL	Internal watchdog of module
EtherCAT_Error	BOOL	Configuration error or watchdog control
Specific_Error	BOOL	Module-specific fault
OptionsSet	BOOL	Sent by module to acknowledge SetOptions

To reset the messages, see Module control

Module-specific messages
There are no module-specific messages for this module.

Conversion time
The analogue signals are converted one by one down every channel. Disabling one or several channels will shorten the entire A/D conversion cycle.

“Filter” in this case means to compute an average when the set filter time is over.

Analogue value conversion runs cyclically and is not synchronized with the receipt of EtherCAT telegrams. The cycle consists of the analogue value conversion plus transmitting the values into the EtherCAT data area.

Conversion time			
Number of channels	**Cycle time in ms (all filters=0)**	**Number of channels**	**Cycle time in ms (all filters=0)**
1	270 µs	5	630 µs
2	360 µs	6	710 µs
3	450 µs	7	800 µs
4	540 µs	8	890 µs

NOTICE

If you are aiming for a high sampling frequency, the EtherCAT master should do the filtering (averaging) because it will normally have much more processing power.

NOTICE

Take the EtherCAT cycle into account to assess how much the values stored by the EtherCAT master are up-to-date. The module described in this section will accept the above times as the ideal EtherCAT cycle setup.

Quality of analogue values

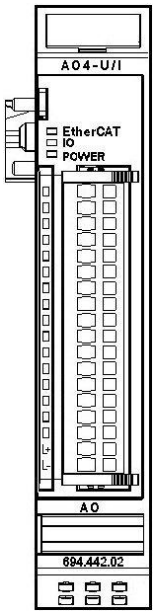
NOTICE

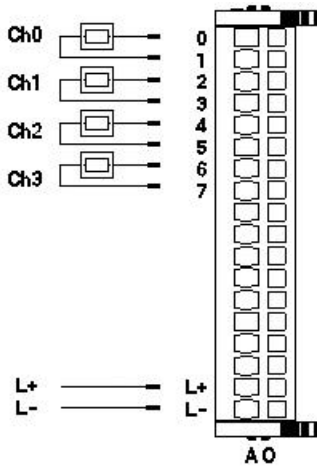
Best results are obtained by
→ connecting the shield of the signal cables to operative earth
→ connecting unused single-ended lines to Ground
→ short-circuiting unused differential inputs

6.3.4. Technical data

AI4/8-U	
Label	E-I/O AI4/8-U 13 BIT
Part no.	204800200
Plug-in connector	18-pole 204800400 (not part of the module)
Analogue inputs	8 single ended or 4 differential
Resolution	13 Bit (1.221 µV unipolar, 2.442 µV bipolar)
Measuring range	0 … 10 V, ± 10 V
Temperature drift	< -15 ppm/°C regarding range limit
Critical frequency	typical 1 MHz
Input resistance	> 100 MΩ
Sampling frequency	1.12 kHz (if all channels are enabled)
Controller	ASIC ET1200
Baud rate	100 Mbit/s
E-bus port	10-pin system plug in side wall
Term. module	not required
Power supply	from coupler through E-bus connector
E-bus load	190 mA

6.4. Analogue outputs voltage / current AO4-U/I





	+	-
Channel0	0	1
Channel1	2	3
Channel2	4	5
Channel3	6	7

Front view of AO4 I/O module I/O connection

6.4.1. Terminals

Power supply to module I/Os
L+: 24 V DC
L-: 0 V

6.4.2. Status LEDs

"EtherCAT" LED
The LED labeled "EtherCAT" indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

“I/O” LED
The LED labeled “I/O” indicates the state of the module's I/Os.

I/O		
State	**LED flash code**	**Explanation**
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 1x	Short circuit
	Red, 2x	Low voltage
	Red, 4x	EtherCAT watchdog control
	Red, 6x	Module-specific fault
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

“Power” LED
The LED labeled "Power" indicates the state of the I/O module's I/O power supply.

Power		
State	**LED flash code**	**Explanation**
On	Green, on	24 V DC supply ok
Off	Off	24 V DC supply not ok

“Channel” LEDs

Channel		
State	**LED flash code**	**Explanation**
On	Green, on	Channel enabled
Off	Off	Channel disabled
Error	Red, 1x	Short circuit
	Red, 3x	Broken wire
	Red, 5x	Excessive temp. of output drivers

6.4.3. Function

The AO4 module has 4 analogue outputs. Every channel can be separately set to the unipolar or bipolar output of voltages or currents.

The letter 'n' in the tables below represents the channel number (n=0...3).

Analogue outputs
Write the output values into the following variables:

Outputs		
Variable	**Data type**	**Explanation**
Channel_n	INT	Output value for channel n (n=0…3)

Analog values voltage
see table page 53
Current
0 ... 0xFFF0 for 0... 20 mA

Module control
The module provides you with various operational options.

To set up the module choose the options as appropriate and accept by setting control bit “SetOptions” to a rising edge. The module will confirm by returning “OptionsSet”.

There are various “module error” bits that the module uses to indicate errors. The states of the error bits are retained and also used for error indication by the “I/O” LED.

To reset the error bits set control bit “ResetError” to a rising edge.

Error bits		
Variable	**Data type**	**Explanation**
SetOptions	BOOL	Rising edge → accepts module options
ResetError	BOOL	Rising edge → acknowledges error

Module options
The following options are available for module AO4:

Module options		
Variable	**Data type**	**Explanation**
Channel_n_On	BOOL	Enables channel n (set to high impedance to disable)
Channel_n_Current	BOOL	Sets channel n to current output mode
Channel_n_n+1_Unipolar	BOOL	Sets channels 1 and 2 or 2 and 3 to unipolar mode
Outputs_Active_Shortcut	BOOL	Leave outputs unchanged after short circuit
Outputs_Active_Undervoltage	BOOL	Leave outputs unchanged after low voltage
Outputs_Active_Specific_Error	BOOL	Leave outputs unchanged after module-specific error
Outputs_Active_EtherCAT_Error	BOOL	Leave outputs unchanged after short circuit
n		0 … 3 Channel number

To set and accept options, see section Module control

Module state
The following states are indicated:

Module state		
Variable	**Data type**	**Explanation**
Shortcut	BOOL	Short circuit (not used)
Undervoltage	BOOL	Low voltage (supplied power < 19.2 V)
Watchdog	BOOL	Internal watchdog of module
EtherCAT_Error	BOOL	Configuration error or watchdog control
Specific_Error	BOOL	Module-specific fault
OptionsSet	BOOL	Sent by module to acknowledge SetOptions

To reset the messages, see Module control

Module-specific messages
Apart from the module error messages, there is a set of messages containing details about the current state of the module:

Messages		
Variable	**Data type**	**Explanation**
Channel_n_Overtemp	BOOL	Temperature of output driver of channel n > 140 °C (automatic switch-off) → Outputs_Active_Shortcut = TRUE
Undervoltage_24	BOOL	Power supplied to module > 19.2V → Outputs_Active_Undervoltage = TRUE
Channel_n_Open	BOOL	Current mode: channel n load is > 500Ω → Specific_Error = TRUE
Channel_n_Shortcut	BOOL	Voltage mode: channel n load is < 600 Ω → Specific_Error = TRUE

These messages are automatically reset when the state concerned has returned to normal.
These messages are summarized as “Specific_Error” in the module status and mapped as “Module-specific error” onto the I/O-LED.

Conversion time
The AO4 module operates with a cycle time of 320µs which is independent of the number of the enabled channels (time from the acquisition of the output values to the start of the D/A converters).

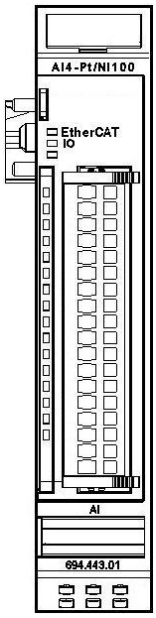
6.4.4. Technical data

AO4-U/I	
Label	E-I/O AO4-U/I 12BIT
Part no.	204801200
Plug-in connector	18-pole 204800400 (not part of the module)
Analogue outputs	4
Resolution	16 bit, 12 bit
Measuring range	0 … 10 V, ± 10 V, 0…20 mA, ± 20 mA
Output frequency	3.125 kHz
Controller	ASIC ET1200
Baud rate	100 Mbit/s
E-bus port	10-pin system plug in side wall
Term. module	not required
Power supply	24 V DC -20% +25%
E-bus load	150 mA

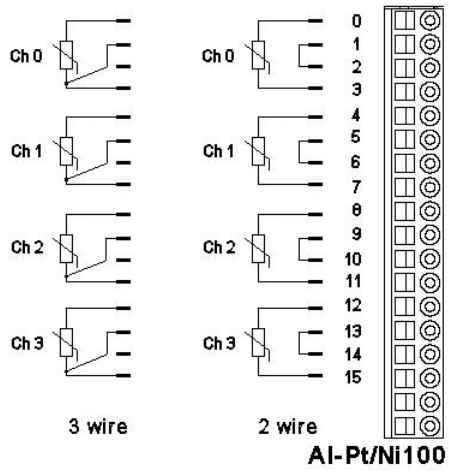
Blank page

7. Temperature modules

7.1. Analogue temperature inputs AI4-Pt/Ni100, AI4-Pt/Ni1000



Front view of Pt/Ni100 I/O module



I/O connection

7.1.1. Terminals

The module needs no separate 24 V connector. Power is supplied to the module through the E-bus connector.
Operative earth / shielding of analog wires → section 3.1.1 Earth

7.1.2. Status LEDs

"EtherCAT" LED
The LED labeled "EtherCAT" indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

“I/O” LED
The LED labeled “I/O” indicates the state of the module's I/Os.

I/O		
State	**LED flash code**	**Explanation**
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 4x	EtherCAT watchdog control
	Red, 6x	Module-specific fault
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

“Power” LED
There is no LED labeled “Power” because a separate power feed is not required.

“Channel” LEDs

Channel		
State	**LED flash code**	**Explanation**
On	Green, on	Channel enabled
Off	Off	Channel disabled
Error	Red	Short circuit, broken wire

7.1.3. Function

Module AI4-Pt/Ni100 has 4 analogue inputs for Pt100 or Ni100 temperature sensors.
It can also measure resistances between 70 and 330 Ω.

Module AI4-Pt/Ni1000 has 4 analogue inputs for Pt1000 or Ni1000 temperature sensors.
It can also measure resistances between 700 and 3000 Ω.

The letter 'n' in the tables below represents the channel number (n=0...3).

Analogue inputs
Check the following variable for the digitized input values:

Inputs				
Variable	**Data type**	**Explanation**		
Channel_n	INT	Value measured on channel n (n= 0…3)		
		Default	in 1/10 °C	
		ResMode	Pt100	in 1/100 Ω
			Pt1000	in 1/10 Ω

Module control
The module provides you with various operational options.

To set up the module choose the options as appropriate and accept by setting control bit “SetOptions” to a rising edge. The module will confirm by returning “OptionsSet”.

There are various “module error” bits that the module uses to indicate errors. The states of the error bits are retained and also used for error indication by the “I/O” LED.
To reset the error bits set control bit “ResetError” to a rising edge.

Error bits		
Variable	**Data type**	**Explanation**
SetOptions	BOOL	Rising edge → accepts module options
ResetError	BOOL	Rising edge → acknowledges error

Module options
The following options are available for module AI4-Pt/Ni100 or 1000:

Module options			
Variable	**Data type**	**Explanation**	
Channel_n_Ni	BOOL	Set channel n to Ni100 sensor	
Channel_n_On	BOOL	Enables channel n	
Channel_n_ResMode	BOOL	Set channel n to resistance mode	
Channel_n_Filter	USINT	Set filter for channel n The arithmetic mean is output after n+1 conversions.	
n		0 … 3	Channel number

To set and accept options, see Module control

Module state
The following module states are indicated:

Module state		
Variable	**Data type**	**Explanation**
Shortcut	BOOL	Not used
Undervoltage	BOOL	Not used
Watchdog	BOOL	Internal watchdog of module
EtherCAT_Error	BOOL	Configuration error or watchdog control
Specific_Error	BOOL	Module-specific fault
OptionsSet	BOOL	Sent by module to acknowledge SetOptions

To reset the messages, see Module control

Module-specific messages
Apart from the module error messages, there is a set of messages containing details about the current state of the module:

Messages		
Variable	**Data type**	**Explanation**
Channel_n_Open	BOOL	- Channel n load > maximum - Broken wire of connector 0 * - Broken wire of connector 3 * - Broken wire of connector 0/3 * → Specific_Error = TRUE
Channel_n_Shortcut	BOOL	- Channel n load < minimum - Short circuit of connector 0-3 * - Broken wire of connector 1 * → Specific_Error = TRUE

* The causes of 'Short circuit' and 'Broken wire 0..3' are shown for channel 0 (equivalent applies to other channels).

These messages are automatically reset when the state concerned has returned to normal.
They are combined into a single “Specific_Error” state of the module and output to the I/O LED as “module-specific error”.

Conversion time
The analogue signals are converted one by one down every channel. Disabling one or several channels will shorten the entire A/D conversion cycle.

'Filter' in this case means to compute an average when the set filter time is over.
Analogue value conversion runs cyclically and is not synchronized with the receipt of EtherCAT telegrams.
The cycle consists of the analogue value conversion plus transmitting the values into the EtherCAT data area.

Channel	
Number of channels	**Cycle time in ms (all filters=0)**
1	32
2	65
3	97
4	129

NOTICE	
	If you are aiming for a high sampling frequency, the EtherCAT master should do the filtering (averaging) because it will normally have much more processing power.

NOTICE	
	Take the EtherCAT cycle into account to assess how much the values stored by the EtherCAT master are up-to-date. The module described in this section will accept the above times as the ideal EtherCAT cycle setup.

Quality of analogue values

NOTICE	
	Best results are obtained by connecting the shield of the signal cables to operative earth.

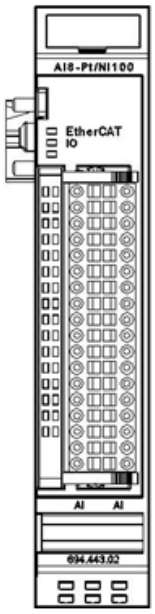
7.1.4. Technical data AI4-Pt/Ni100

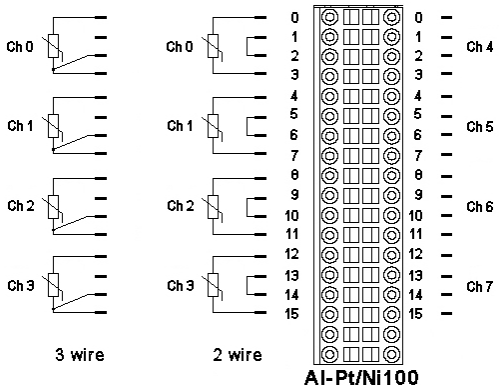
AI4-Pt/Ni100	
Label	E-I/O AI4-PT/NI100 16 BIT
Part no.	204801300
Plug-in connector	18-pole 204800400 (not part of the module)
Analogue inputs	4
Resolution	16 bit (resistance 0.01 Ω, temperature 0.1°C)
Pt100 measuring range	- 75°C…+ 670°C
Ni100 measuring range	- 60°C…+ 250°C
Resistance	70…330 Ω
Temperature drift	< ± 50 ppm/°C regarding range limit
Critical frequency	typical 2 Hz
Measurement current	< 0.50 mA
Sampling frequency	> 7.75 Hz (if all channels are enabled)
Controller	ASIC ET1200
Baud rate	100 Mbit/s
E-bus port	10-pin system plug in side wall
Term. module	not required
Power supply	24 V DC -20% +25%
E-bus load	150 mA

7.1.5. Technical data AI4-Pt/Ni1000

AI4-Pt/Ni1000	
Label	E-I/O AI4-PT/NI1000 16 BIT
Part no.	204802800
Plug-in connector	18-pole 204800400 (not part of the module)
Analogue inputs	4
Resolution	16 bit (resistance 0.1 Ω, temperature 0.1°C)
Pt100 measuring range	- 75°C…+ 570°C
Ni100 measuring range	- 60°C…+ 250°C
Resistance	700…3000 Ω
Temperature drift	< ± 60 ppm/°C regarding range limit
Critical frequency	typical 2 Hz
Measurement current	< 0.12 mA
Sampling frequency	> 7.75 Hz (if all channels are enabled)
Controller	ASIC ET1200
Baud rate	100 Mbit/s
E-bus port	10-pin system plug in side wall
Term. module	not required
Power supply	24 V DC -20% +25%
E-bus load	150 mA

7.2. Analogue temperature inputs AI8-Pt/Ni100





Front view of Pt/Ni100 I/O module I/O connection

7.2.1. Terminals

The module needs no separate 24 V connector. Power is supplied to the module through the E-bus connector. Operative earth / shielding of analog wires → section 3.1.1 Earth

7.2.2. Status LEDs

"EtherCAT" LED
The LED labeled "EtherCAT" indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

“I/O” LED
The LED labeled “I/O” indicates the state of the module's I/Os.

I/O		
State	**LED flash code**	**Explanation**
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 4x	EtherCAT watchdog control
	Red, 6x	Module-specific fault
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

“Power” LED
There is no LED labeled “Power” because a separate power feed is not required.

“Channel” LEDs

Channel		
State	**LED flash code**	**Explanation**
On	Green, on	Channel enabled
Off	Off	Channel disabled
Error	Red	Short circuit, broken wire

7.2.3. Function

Module AI8-Pt/Ni100 has 8 analogue inputs for Pt100 or Ni100 temperature sensors.
It can also measure resistances between 70 and 330 Ω.

The letter 'n' in the tables below represents the channel number (n=0...7).

Analogue inputs
Check the following variable for the digitized input values:

Inputs				
Variable	**Data type**	**Explanation**		
Channel_n	INT	Value measured on channel n (n= 0…7)		
		Default	in 1/10 °C	
		ResMode	Pt100	in 1/100 Ω

Module control
The module provides you with various operational options.

To set up the module choose the options as appropriate and accept by setting control bit “SetOptions” to a rising edge. The module will confirm by returning “OptionsSet”.

There are various “module error” bits that the module uses to indicate errors. The states of the error bits are retained and also used for error indication by the “I/O” LED.
To reset the error bits set control bit “ResetError” to a rising edge.

Error bits		
Variable	**Data type**	**Explanation**
SetOptions	BOOL	Rising edge → accepts module options
ResetError	BOOL	Rising edge → acknowledges error

Module options
The following options are available for module AI8-Pt/Ni100:

Module options			
Variable	**Data type**	**Explanation**	
Channel_n_Ni	BOOL	Set channel n to Ni100 sensor	
Channel_n_On	BOOL	Enables channel n	
Channel_n_ResMode	BOOL	Set channel n to resistance mode	
Channel_n_Filter	USINT	Set filter for channel n The arithmetic mean is output after n+1 conversions.	
n		0 … 7	Channel number

To set and accept options, see Module control

Module state
The following module states are indicated:

Module state		
Variable	**Data type**	**Explanation**
Shortcut	BOOL	Not used
Undervoltage	BOOL	Not used
Watchdog	BOOL	Internal watchdog of module
EtherCAT_Error	BOOL	Configuration error or watchdog control
Specific_Error	BOOL	Module-specific fault
OptionsSet	BOOL	Sent by module to acknowledge SetOptions

To reset the messages, see Module control

Module-specific messages
Apart from the module error messages, there is a set of messages containing details about the current state of the module:

Messages		
Variable	**Data type**	**Explanation**
Channel_n_Open	BOOL	- Channel n load > maximum - Broken wire of connector 0 * - Broken wire of connector 3 * - Broken wire of connector 0/3 * → Specific_Error = TRUE
Channel_n_Shortcut	BOOL	- Channel n load < minimum - Short circuit of connector 0-3 * - Broken wire of connector 1 * → Specific_Error = TRUE

* The causes of 'Short circuit' and 'Broken wire 0..3' are shown for channel 0 (equivalent applies to other channels).

These messages are automatically reset when the state concerned has returned to normal.
They are combined into a single “Specific_Error” state of the module and output to the I/O LED as “module-specific error”.

Conversion time
The analogue signals are converted one by one down every channel. Disabling one or several channels will shorten the entire A/D conversion cycle.

'Filter' in this case means to compute an average when the set filter time is over.
Analogue value conversion runs cyclically and is not synchronized with the receipt of EtherCAT telegrams.
The cycle consists of the analogue value conversion plus transmitting the values into the EtherCAT data area.

Channel			
Number of channels	**Cycle time in ms (all filters=0)**	**Number of channels**	**Cycle time in ms (all filters=0)**
1	34	5	162
2	66	6	194
3	98	7	226
4	130	8	258

NOTICE

If you are aiming for a high sampling frequency, the EtherCAT master should do the filtering (averaging) because it will normally have much more processing power.

NOTICE

Take the EtherCAT cycle into account to assess how much the values stored by the EtherCAT master are up-to-date. The module described in this section will accept the above times as the ideal EtherCAT cycle setup.

Quality of analogue values

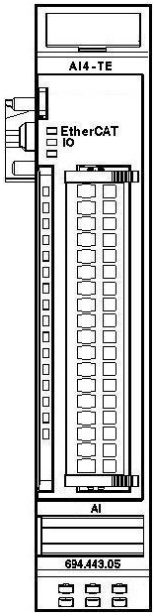
NOTICE

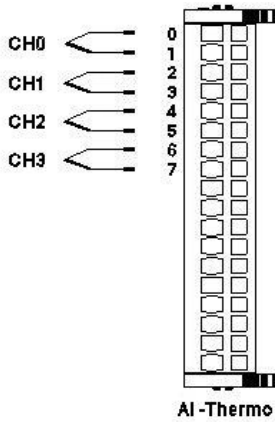
Best results are obtained by connecting the shield of the signal cables to operative earth.

7.2.4. Technical data AI8-Pt/Ni100

AI8-Pt/Ni100	
Label	E-I/O AI8-PT/NI100 16 BIT
Part no.	204800500
Plug-in connector	36-pole 204800300 (not part of the module)
Analogue inputs	8
Resolution	16 bit (resistance 0.01 Ω, temperature 0.1°C)
Pt100 measuring range	- 75°C…+ 670°C
Ni100 measuring range	- 60°C…+ 250°C
Resistance	70…330 Ω
Temperature drift	< ± 50 ppm/°C regarding range limit
Critical frequency	typical 2 Hz
Measurement current	< 0.50 mA
Sampling frequency	> 3.88 Hz (if all channels are enabled)
Controller	ASIC ET1200
Baud rate	100 Mbit/s
E-bus port	10-pin system plug in side wall
Term. module	not required
Power supply	24 V DC -20% +25%
E-bus load	170 mA

7.3. Analogue temperature inputs AI4





Front view of AI4-TE I/O module I/O connection

7.3.1. Terminals

The module needs no separate 24 V connector. Power is supplied to the module through the E-bus connector. Operative earth / shielding of analog wires → section 3.1.1 Earth

7.3.2. Status LEDs

"EtherCAT" LED
The LED labeled "EtherCAT" indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

“I/O” LED
The LED labeled “I/O” indicates the state of the module's I/Os.

I/O		
State	**LED flash code**	**Explanation**
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 4x	EtherCAT watchdog control
	Red, 6x	Module-specific fault
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

“Power” LED
There is no LED labeled “Power” because a separate power feed is not required.

“Channel” LEDs

Channel		
State	**LED flash code**	**Explanation**
On	Green, on	Channel enabled
Off	Off	Channel disabled
Error	Red	Measuring value is out of range

7.3.3. Function

Module AI4-TE has 4 analogue inputs for thermo-element sensors. It can also measure mV-voltages.

The letter 'n' in the tables below represents the channel number (n=0...3).

Analogue inputs
Check the following variable for the digitized input values:

Inputs			
Variable	**Data type**	**Explanation**	
Channel_n	INT	Measuring value of channel n (n = 0…3)	
		mV-Mode	in µV resp. 2 µV
		Default	in 1/10 °C

Module control
The module provides you with various operational options.
To set up the module choose the options as appropriate and accept by setting control bit “SetOptions” to a rising edge. The module will confirm by returning “OptionsSet”.

There are various “module error” bits that the module uses to indicate errors. The states of the error bits are retained and also used for error indication by the “I/O” LED.

To reset the error bits set control bit “ResetError” to a rising edge.

Error bits		
Variable	**Data type**	**Explanation**
SetOptions	BOOL	Rising edge → accepts module options
ResetError	BOOL	Rising edge → acknowledges error

Module options
The following options are available for module AI4-TE:

Module options			
Variable	**Data type**	**Explanation**	
Channel_n_SensorType	USINT	Sensor type	
		16#00	mV: not used
		16#10	mV: -40 ..+65 mV, values in 2 µV
		16#04	Type K: not used
		16#14	Type K: -200°C .. +1372°C in 0.1°C
Channel_n_On	BOOL	Enable channel n	
Channel_n_Filter	USINT	Set filter for channel n The arithmetic mean is output after n+1 conversions.	
n		0 … 3	Channel number

To set and accept options, see Module control

Module state
The following module states are indicated:

Module state		
Variable	**Data type**	**Explanation**
Shortcut	BOOL	Not used
Undervoltage	BOOL	Not used
Watchdog	BOOL	Internal watchdog of module
EtherCAT_Error	BOOL	Configuration error or watchdog control
Specific_Error	BOOL	Module-specific fault
OptionsSet	BOOL	Sent by module to acknowledge SetOptions

To reset the messages, see Module control

Module-specific messages
Apart from the module error messages, there is a set of messages containing details about the current state of the module:

Messages		
Variable	**Data type**	**Explanation**
Channel_n_ Out_of_Range	BOOL	Measuring value is out of range.

These messages are automatically reset when the state concerned has returned to normal.
They are combined into a single “Specific_Error” state of the module and output to the I/O LED as “module-specific error”.

Conversion time
The analogue signals are converted one by one down every channel. Disabling one or several channels will shorten the entire A/D conversion cycle.

'Filter' in this case means to compute an average when the set filter time is over.
Analogue value conversion runs cyclically and is not synchronized with the receipt of EtherCAT telegrams.
The cycle consists of the analogue value conversion plus transmitting the values into the EtherCAT data area.

Channel	
Number of channels	**Cycle time in ms (all filters=0)**
1	35
2	67
3	99
4	131

NOTICE	If you are aiming for a high sampling frequency, the EtherCAT master should do the filtering (averaging) because it will normally have much more processing power.

NOTICE	Take the EtherCAT cycle into account to assess how much the values stored by the EtherCAT master are up-to-date. The module described in this section will accept the above times as the ideal EtherCAT cycle setup.

Quality of analogue values

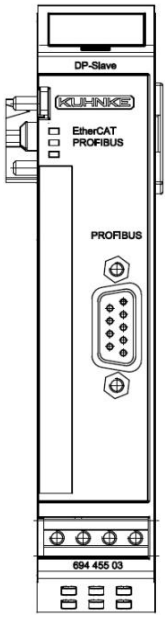
NOTICE	Best results are obtained by connecting the shield of the signal cables to operative earth.

7.3.4. Technical data

AI4	
Label	E-I/O AI4-THERMO 16 BIT
Part no.	204801400
Plug-in connector	18-pole 204800400 (not part of the module)
Analogue inputs	4
Resolution	16 bit
mV measuring range	mV: -40 ..+65 mV, values in 2 µV
Type K measuring range	Typ K: -200°C .. +1372°C in 0.1°C
Measurement failure 25°C	< ± 0.4% regarding range limit
Less measurement failure	on demand
Cold junction compensation	yes
Critical frequency	typical 0.33 Hz
Sampling frequency	> 7.63 Hz (if all channels are enabled)
Controller	ASIC ET1200
Baud rate	100 Mbit/s
E-bus port	10-pin system plug in side wall
Term. module	not required
Power supply	24 V DC -20% +25%
E-bus load	150 mA

8. Communication modules

8.1. PROFIBUS-DP-Slave



Front view of PROFIBUS-DP-Slave module

Pinning		
Pin	**Signal**	**Explanation**
1	Shield	Shield/functional ground
2	M24	Not connected
3	RxD/TxD-P	Receive/Transmit data – plus, B wire
4	CNTR-P	Repeater control signal (direction control), RTS signal
5	DGND	Data ground (reference potential for VP)
6	VP	Supply voltage – plus, (P5V)
7	P24	Not connected
8	RxD/TxD-N	Receive/Transmit data – minus, A wire
9	CNTR-N	Repeater control signal (direction control)

Pinning PROFIBUS

8.1.1. Terminals

The module needs no separate 24 V connector. Power is supplied to the module through the E-bus connector.
Operative earth / shielding of analog wires → section 3.1.1 Earth

8.1.2. Status LEDs

"EtherCAT" LED
The LED labeled "EtherCAT" indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

LED "PROFIBUS"
The LED labeled "PROFIBUS" indicates the state of the module regarding PROFIBUS.

PROFIBUS		
State	**LED flash code**	**Explanation**
Ok	Green, on	No error
Error	Red, flashing light	Connection fault
Start, Defect	Red, on	Module not initialized

8.1.3. Function

The module PROFIBUS-DP-Slave is an EtherCAT/PROFIBUS-DP gateway. It accomplishes the data transfer between an EtherCAT system and a PROFIBUS-DP system.

Data
Utilizable data you will find in 4 groups of input variables and 4 groups of output variables:

Utilizable data			
Variable	**Data type**	**Number**	**Explanation**
InByteM1_0 .. _15	USINT	16	Input data module1 Byte_0 ..Byte_15
InByteM2_0 .. _31	USINT	32	Input data module2 Byte_0 ..Byte_31
InByteM3_0 .. _47	USINT	48	Input data module3 Byte_0 ..Byte_47
InByteM4_0 .. _63	USINT	64	Input data module4 Byte_0 ..Byte_63
OutByteM1_0 .. _15	USINT	16	Output data module1 Byte_0 ..Byte_15
OutByteM2_0 .. _31	USINT	32	Output data module2 Byte_0 ..Byte_31
OutByteM3_0 .. _47	USINT	48	Output data module3 Byte_0 ..Byte_47
OutByteM4_0 .. _63	USINT	64	Output data module4 Byte_0 ..Byte_63

See section "Configuring of the data modules" for configuring the data

Module control
The module provides no operational options but a PROFIBUS-address, which is set by the EtherCAT Master. The module indicates errors by different "Module state" bits. These error bits are stored. To reset the error bits set control bit "ResetError" to a rising edge.

Error bits		
Variable	**Data type**	**Explanation**
SetOptions	BOOL	Rising edge → accepts the PROFIBUS address
ResetError	BOOL	Rising edge → acknowledges error

SPC3 address
The PROFIBUS-DP-Slave address is set by the following variable:

SPC3		
Variable	**Data type**	**Explanation**
Address	USINT	PROFIBUS-DP-Slave Address

The assumption of the address is released with the rising edge of SetOptions. The execution is indicated with OptionsSet. Since revision 2 the PROFIBUS DP slave address can be changed also at runtime.

Module state
The following module states are indicated:

Module state		
Variable	**Data type**	**Explanation**
Shortcut	BOOL	Not used
Undervoltage	BOOL	Not used
Watchdog	BOOL	Internal watchdog of module
EtherCAT_Error	BOOL	Configuration error or watchdog control
Specific_Error	BOOL	Not used
OptionsSet	BOOL	Sent by module to acknowledge SetOptions

To reset the messages, see Module control

Module-specific messages
Apart from the module error messages, there is a set of messages containing details about the current state of the module:

Messages		
Variable	**Data type**	**Explanation**
ProfibusRunning	BOOL	PROFIBUS runs

Configuring of the data modules
For the configuration of the EtherCAT and the PROFIBUS the appropriate configuration files are needed:
→ **EtherCAT:** Berghof EIO Modules.xml
→ **PROFIBUS:** E-IO DP-S.GSD

Number and size of the data modules are configurable. The relationship of input data and output data is always thereby 1:1.
Select the desired data modules in the respective configurator tools.

NOTICE	Make sure that configuring on the EtherCAT side and the PROFIBUS side must be implemented identically.

PROFIBUS
For the configuration of the PROFIBUS you need E-IO DP-S.GSD. Those is to be imported into the PROFIBUS Master configurator which can be used.

Example
Maximally 4 modules with a maximum data area length of 160 bytes for each direction can be selected.
The individual modules are consistent for themselves.
The module provides the following module-specific diagnosis data “Ext_Diag_Data”:

Ext_Diag_Data		
Octet	**Value**	**Explanation**
1..4	…	Standard diagnosis
5	0x43	Standard diagnosis: Module Id. 6943
6	0x69	
7	3	3 (1+2) byte extended diagnosis
8	0	EtherCAT runs
	6	EtherCAT error
9	0x11	Revision 1
	0x12	Revision 2 (with DP address change)

EtherCAT
You need Berghof EIO Modules.xml for the EtherCAT configuration. Those is to be imported in the EtherCAT Master configurator which can be used.

NOTICE	Online-configuration (Scan Boxes = Reading of the configuration data from the connected EtherCAT devices) is not possible because of a too large amount of data).

Example
Berghof EC1000 as EtherCAT Master, configuration with EtherCAT configurator in CoDeSys 2.3.
For the configuration of the EtherCAT appropriate PDOs are available:

PDOs			
Index	**Input variable**	**Index**	**Output variable**
0x1601	ModulKontrolle	0x1A01	ModulStatus
0x1602	Modulspezifische Meldungen	0x1A02	SPC3address_Adress
0x1603	Profibusdata_InByteM1_0 .. _15	0x1A03	Profibusdata_OutByteM1_0 .. _15
0x1604	Profibusdata_InByteM2_0 .. _31	0x1A04	Profibusdata_OutByteM2_0 .. _31
0x1605	Profibusdata_InByteM3_0 .. _47	0x1A05	Profibusdata_OutByteM3_0 .. _47
0x1606	Profibusdata_InByteM4_0 .. _63	0x1A06	Profibusdata_OutByteM4_0 .. _63

NOTICE

Make sure that configuring on the EtherCAT side and the PROFIBUS side must be implemented identically.

Selection of the PROFIBUS address
The PROFIBUS address is written into the variable “Address” of the PLC program and transmitted as PDO 1602 to the PROFIBUS-DP-Slave module.
With the setting of the bit “SetOption” the assumption of the address in the module becomes released. The module acknowledges the assumption of the address by setting of “OptionsSet”.
After receipt of a valid PROFIBUS address the module initializes the PROFIBUS. If a master accesses the module over the PROFIBUS and transfers a valid configuration, the professional bus is functional. This is indicated by the bit “ProfibusRunning”. Only then data exchange EtherCAT <- -> PROFIBUS is possible.
Since revision 2 the address change at runtime is possible. The connection with the PROFIBUS master will be cut for a short time but the master will rebuild the connection to the new address by its GAP update. The status of the connection is shown in “ProfibusRunning”.

Example
Setting of usiDP_Adresse as DP Slave address

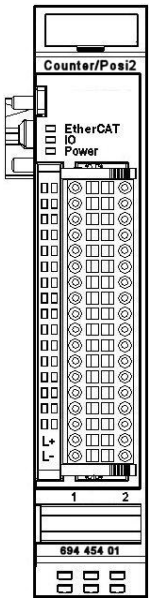
```
(* Start (Single action) *)
Term2_Address:=usiDP_Adresse;              (* Copying the DP-Slave address *)
Term2_SetOptions_Byte.0:=TRUE;             (* Start of the address setting *)

(* Controlling *)
IF Term2_SetOptions_Byte.0=TRUE THEN
    IF Term2_Shortcut_Byte.7=TRUE THEN     (*Wait for confirmation *)
        Term2_SetOptions_Byte.0=FALSE;     (* Reset *)
    END_IF
END_IF
```

8.1.4. Technical data PROFIBUS-DP-Slave

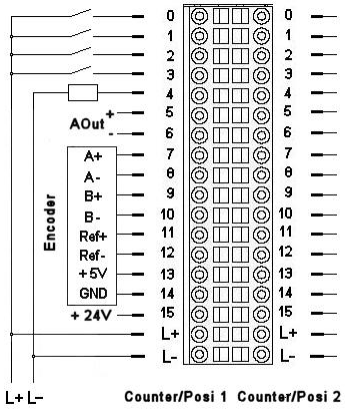
PROFIBUS	
Label	E-I/O DP-SLAVE
Part no.	204802600
Fieldbus1 (System)	EtherCAT 100 Mbit/s
EtherCAT file	Berghof EIO Modules.xml
Fieldbus2	PROFIBUS-DP-Slave
Implementation type	VPC3
Connector	D-SUB Plug 9-pole female (not part of the module)
Baud rate	max. 12 Mbit/s
Detection	automatically
Addressing	via EtherCAT variable
GSD file	E-IO DP-S.GSD
WxHxD	25x120x90 mm
Mounting	35 mm DIN top hat rail
Controller	ASIC ET1200
Connection	10-pole system plug at the side wall
Term. module	not required
Power supply	from EtherCAT Coupler via E-bus plug
E-bus load	210 mA
Galvanic separation	Separated from one another and versus the bus
Storage temperature	-25°C…+70°C
Operating temperature	0°C…+55°C
Relative humidity	5%...95% without dewing
Protection	IP20
Interference immunity	Zone B

9. Counter modules

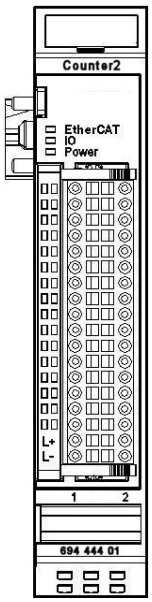
9.1. Counters with analogues outputs Counter/Posi2 5V, Counter2 5V



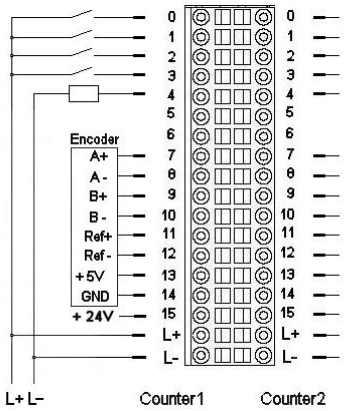
Front view of Counter/Posi2 I/O module



Pinning Counter/Posi2



Front view of Counter2 I/O module



Pinning Counter2

9.1.1. Terminals

Counter/Posi2, Counter2		
Pin	**Signal**	**Explanation**
0..3	In_0..3	Digital inputs
4	Out_0	Digital output
5..6	A_Out	Analogue output (Counter/Posi2 only)
7..12	A, B, Ref	Encoder signals
13..14	5 V	Encoder supply 5 V (0.2 A fuse)
15	+24 V	Initiator supply +24 V (0.2 A fuse)
16..17	24 V	Module supply

Operative earth / shielding of analog wires → section 3.1.1 Earth

9.1.2. Status LEDs

"EtherCAT" LED
The LED labeled "EtherCAT" indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

"I/O" LED
The LED labeled "I/O" indicates the state of the module's I/Os.

I/O		
State	**LED flash code**	**Explanation**
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 2x	Low voltage
	Red, 3x	Watchdog internal
	Red, 4x	EtherCAT watchdog control
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

“Power” LED

The LED labeled "Power" indicates the state of the I/O module's I/O power supply.

Power		
State	**LED flash code**	**Explanation**
On	Green, on	24 V DC supply ok
Off	Off	24 V DC supply not ok

Status LEDs of the I/Os

The Status LEDs of the several I/Os indicate the state of the individual digital I/Os.

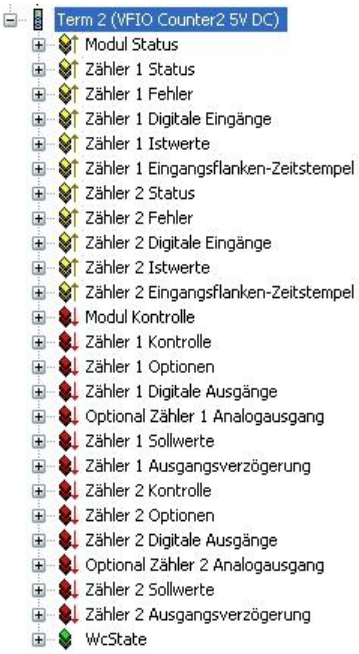
Status			
Pin	**Voltage**	**LED**	**Explanation**
0..3	24 V	Green	Digital inputs
4	24 V	Green	Digital output
7, 9, 11	5 V	Green	Encoder signals A, B, Ref

9.1.3. Function

The module Counter2 has 2 identical channels.

Each channel has terminals for one encoder and 4 digital inputs and 1 digital output.

The Counter/Posi2 module has 1 additional analogue output.



There are structured groups of variables for.

- → Controlling and watching the entire module: Modul Kontrolle/Modul Status (Module control/Module status)
- → Controlling and watching of Counter 1 resp. 2: Optionen/Kontrolle/Status/Fehler (Options/Control/ Status/Errors)
- → Counter values of Counter 1 resp. 2: Sollwerte/Istwerte (Set values/Current values)
- → State of the digital I/Os of Counter 1 resp. 2: Digitale Ausgänge/Digitale Eingänge/Eingangsflanken-Zeitstempel/Ausgangsverzögerung (Digital outputs/Digital inputs/Input change time stamp/ Output delay)
- → State of the analogue outputs of Counter 1 resp. 2: Optional Analogausgang (Analogue output, Function with module Counter/Posi2 only)

Principle of control (controller) and status
If a control bit is set (=TRUE), the module will operate the corresponding function due to the rising edge of the bit.
The module indicates the execution of the function by setting the corresponding status bit (=TRUE). When the control bit is reset (=FALSE) the module will also reset the status bit (=FALSE).

NOTICE

In the following the functions of the counter module are described by Counter/Posi 1. For Counter/Posi 2 the data are valid accordingly.

Frame- or DC- synchronous mode
Dependent on whether Distributed Clocks (DC) are used or not, the module adjusts itself independently on the suitable mode of operation.
The module is preset on Frame synchronous mode. With the receipt of the first DC telegram the module is changed over to DC-synchronous mode and maintains this mode of operation up to next switching off.

Frame-synchronous
The EtherCAT master sends EtherCAT frames with the output data for the module. With the arrival of such frame the output data are taken over and processed by the module. The module places its input data into the EtherCAT frame, so that the master can receive it.

DC-synchronous
If the module is adjusted to DC-synchronous mode, it produces interrupts according to the rules of the Distributed Clocks DC.

The EtherCAT master sends also here EtherCAT Frames away with the output data for the module. With the arrival of such frames the output data of the module are taken over however then processed only if a DC interrupt has occurred. With the DC interrupt the module places its input data into a buffer, from which they are transported with the next EtherCAT Frame to the master.
With this method time-synchronous functions for digital inputs and digital outputs for several modules in one EtherCAT network are possible.

9.1.4. Controlling and watching the entire module

The module control is carried out with the variables from the group “Modul Kontrolle”. The status of the settings having been carried out becomes shown in the variables of the group “Modul Status”.

Modulkontrolle (Module Control)
The module does not have any options at present.

The module reports faults with different “Modul Status” bits. These bits are stored. They can be reset only then if the fault is not there any more. Send a rising edge to “ResetError” to reset the “Modul Status” bits.

Error bits		
Variable	**Data type**	**Explanation**
ResetError	BOOL	Rising edge → acknowledges error

Modulstatus (Module Status)
The following module status bits are indicated:

Module status		
Variable	**Data type**	**Explanation**
LowSupplyVoltage	BOOL	Low voltage
Watchdog	BOOL	Module internal Watchdog
EtherCAT_Error	BOOL	Configuration error or watchdog control

Acknowledgement see Module control

9.1.5. Controlling / Watching Counter 1

The setting of the functions of the counter is carried out with the variables from the group “Zähler 1 Optionen”.
The module control is carried out with the variables from the group “Zähler 1 Kontrolle”.
The status of the settings is indicated in the variables of the group “Zähler 1 Status”.

NOTICE

The use of the counter module in a variety of different applications is possible by use of the variables from the groups of Zähler 1-Optionen, -Kontrolle and –Status.

Zähler 1 Optionen (Counter 1 Options)
The module offers you different options for the operation of Counter 1. The options are set in the module with the help of the control bit “SetOptions_1” (see also Zähler 1 **Kontrolle**) and then valid up to the next setting procedure.

→ At first select the options, please. For taking over send a rising edge to the control bit “SetOptions_1”.
→ The module indicates the execution by “OptionsSet_1=TRUE”.
→ When “SetOptions_1” becomes FALSE again, the module responses by “OptionsSet_1=FALSE”. So the module is ready for the next setting process.

Counter 1 Options				
Variable	**Data type**	**Value**	**Explanation**	
Enable_Compare_1	BOOL	0	Deactivate compare function	
		1	Activate compare function	
SelectEncoder_1	BOOL	0	A, B, Ref with detection of direction	
		1	Event counter at A	B=0 down
				B=1 up
SetResolution_1	BOOL		Only if SelectEncoder=1 (Event counter)	
		0	Rising and falling edges	
		1	Only rising edges	
ControlOutput_1	BOOL	0	Output_0_0 is a regular digital output	
		1	Output_0_0 is controlled by the compare function.	

Zähler 1 Kontrolle (Counter 1 Control)
Enabling and disabling of counting and referencing are determined by the state of the control variables. Set and Reset functions are activated by setting of the appropriate variable. The execution is indicated in the corresponding status variable. If the control variable is reset, the counter module also resets the corresponding status variable.

Counter 1 Control			
Variable	**Data type**	**Value**	**Explanation**
SetOptions_1	BOOL	0/1	Take over “Zähler 1 Optionen”
ResetReferenced_1	BOOL	0/1	Reset of status bit “Referenced_1”
ResetCompared_1	BOOL	0/1	Reset of status bit “Compared_1”
ResetCaptured_1	BOOL	0/1	Reset of status bit “Captured_1”
EnableCounter_1	BOOL	0	Disable counter
		1	Enable counter
EnableReferencing_1	BOOL	0	Disable Referencing
		1	Enable Referencing
SetCounter_1	BOOL	0/1	Set counter to preset value
SetCompare_1	BOOL	0/1	Set compare value register
SetPreset_1	BOOL	0/1	Set preset value register
SetMax_1	BOOL	0/1	Set maximum value register

Zähler 1 Status (Counter 1 State)

The status variables indicate the status of the counter. This concerns the appearance of events and the indication of the execution of settings.

Counter 1 Status		
Variable	**Data type**	**Explanation**
Counting_1	BOOL	Counter is enabled
Referenced_1	BOOL	Reference function was executed, reset by ResetReferenced_1
Clockwise_1	BOOL	Counter counts up
Compared_1	BOOL	Compare function was executed, reset by ResetCompared_1
Captured_1	BOOL	Capture function was executed, reset by ResetCaptured_1
CounterSet_1	BOOL	Counter is set to preset value
CompareSet_1	BOOL	Compare value is set
PresetSet_1	BOOL	Preset value is set
MaxSet_1	BOOL	Maximum value is set
OptionsSet_1	BOOL	Options of counter 1 are set.

Zähler 1 Fehler (Counter 1 Errors)
The variables are provided for the indication of error states.

Counter 1 Errors		
Variable	**Data type**	**Explanation**
Err_Reserved_1_x	BOOL	Reserved error bits

9.1.6. Counter values of Zähler 1 (Counter 1)

Zähler 1 Sollwerte (Counter 1 Set Values)
The counter can be preset with different set values. That is done by help of the variable “SetValue_1”. After setting the following control bits from the group “Zähler 1 Kontrolle” the content of “SetValue_1” will be copied as set value in the corresponding registers.

Counter 1 Set Values	
Variable	**Explanation**
SetCounter_1	Copy “SetValue_1” to the current counter value
SetCompare_1	Copy "SetValue_1" to the compare value register
SetPreset_1	Copy "SetValue_1" to the preset value register
SetMax_1	Copy "SetValue_1" to the maximum value register

The current set values can be read in the variable “SelectedValue” from the “Zähleristwerte” (Counter current values) group.
Select by the variable “Select_1”, which value you want to see in the variable “SelectedValue”.

SelectedValue			
Variable	**Data type**	**Explanation**	
Select_1	USINT	Selection which value of counter1 shall be displayed in the variable “SelectedValue”.	
		0	none
		1	Vergleichswert (Compare value)
		2	Vorwahlwert (Preset value)
		3	Endwert (Max value)
		4	Fangwert (Capture value)
		5	Counter pulses/second
		6	Revolutions per minute
		128	Version info
SetValue_1	DINT	Set value of counter 1 (source) to copy (operated by a control bit) into a set value register (target).	

Zähler 1 Istwerte (Counter 1 Actual Values)
These variables display the current counter value and the current set values. The set values are represented multiplexedly in the variable "SelectedValue" (Selection by Select_1).

Counter 1 Actual Values			
Variable	**Data type**	**Explanation**	
Counter_1	DINT	Current value of counter 1	
Selected_1	USINT	Selection of that value of counter 1, which is displayed in the variable SelectedValue (value of Select_1 read from the module).	
		0	none
		1	Vergleichswert (Compare value)
		2	Vorwahlwert (Preset value)
		3	Endwert (Max value)
		4	Fangwert (Capture value)
		5	Counter pulses/second
		6	Revolutions per minute
		128	Version info
SelectedValue	DINT	Selected current value of counter 1	

Version Info				
Byte	**3**	**2**	**1**	**0**
Explanation	Version #	Release	Level	Type code
Example	0x02	0x00	0x00	0x53
	2	0	0	S

9.1.7. Digital I/Os

Zähler 1 (Counter 1) Digital inputs
The variables indicate the status of the digital inputs.

Digital inputs		
Variable	**Data type**	**Explanation**
Input_0_0	BOOL	Digital input 0
Input_0_1	BOOL	Digital input 1
Input_0_2	BOOL	Digital input 2
Input_0_3	BOOL	Digital input 3
In_Output_0_0	BOOL	Status of digital output 0 (reads the status)

Zähler 1 (Counter 1) Input edge timestamp

The variables indicate the time, on which the status of the digital input has changed.
When the time measurement is started depends on the mode of operation (see also section 9.1.3 Frame-synchronous, DC-synchronous).

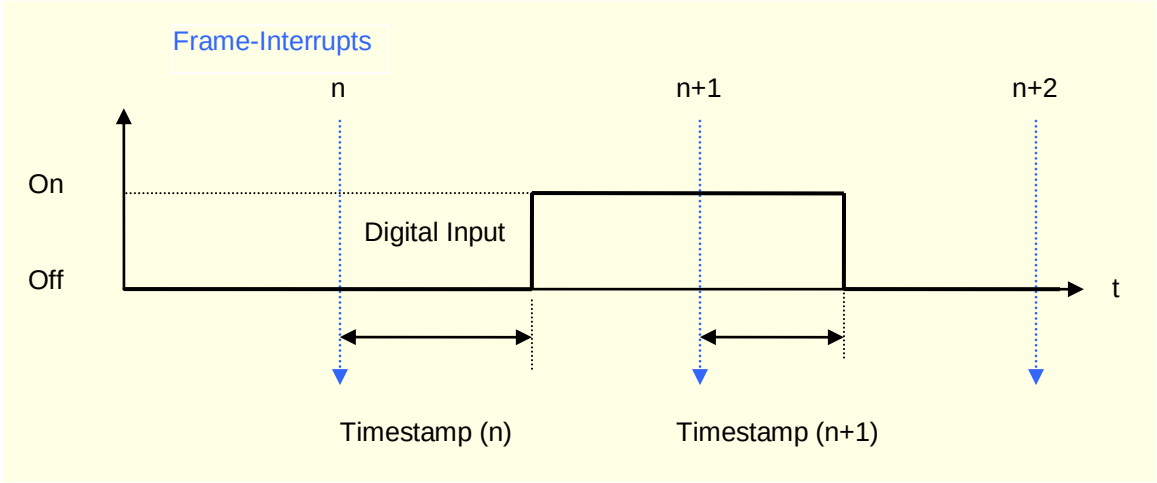
Input edge timestamp		
Variable	**Data type**	**Explanation**
Input_0_0_TS	UINT	Time stamp for digital input 0 (Hardware Capture)
Input_0_1_TS	UINT	Time stamp for digital input 1 (Software Polling)
Input_0_2_TS	UINT	Time stamp for digital input 2 (Software Polling)
Input_0_3_TS	UINT	Time stamp for digital input 3 (Software Polling)

NOTICE

The time stamp is metered between frame- or DC-interrupts and signal changes on the input in µs.
The value of the time stamp becomes to 0xFFFF, when no signal change takes place between two frame- or DC-interrupts.

In frame-synchronous mode

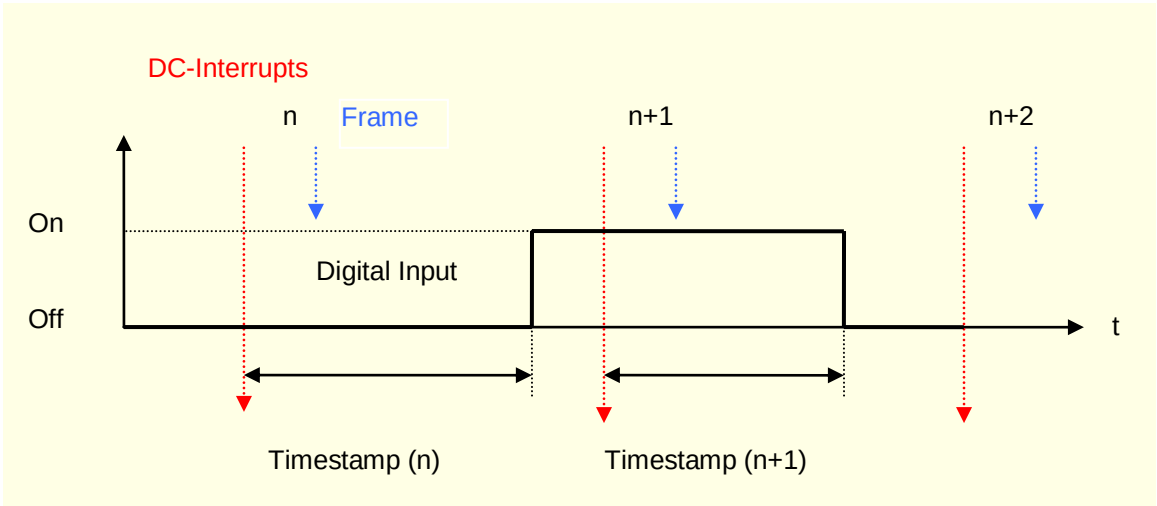
The time from the last frame-interrupt to the status change of the input is stored in the time stamp and sent in the following frame to the EtherCAT Master.



Frame-synchronous		
Frame	**Digital Input**	
	Variable	**Time stamp**
n+1	TRUE	Time stamp (n)
n+2	FALSE	Time stamp (n+1)

In DC-synchronous mode

The time from the last DC-interrupt to the status change of the input is stored in the time stamp and sent in the following frame to the EtherCAT Master.



DC-synchronous		
Frame	**Digital Input**	
	Variable	**Time stamp**
n+1	TRUE	Time stamp (n)
n+2	FALSE	Time stamp (n+1)

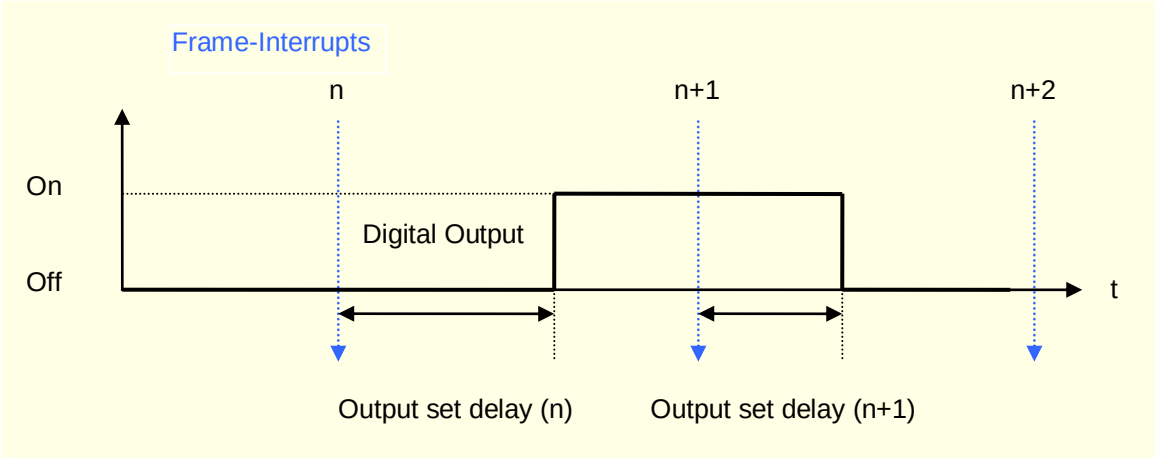
Digital outputs
The variables indicate the status of the digital outputs.

Digital outputs		
Variable	**Data type**	**Explanation**
Output_0_0	BOOL	Digital output 0

Output set delay (in preparation)
This variable defines the time, when the output is set.

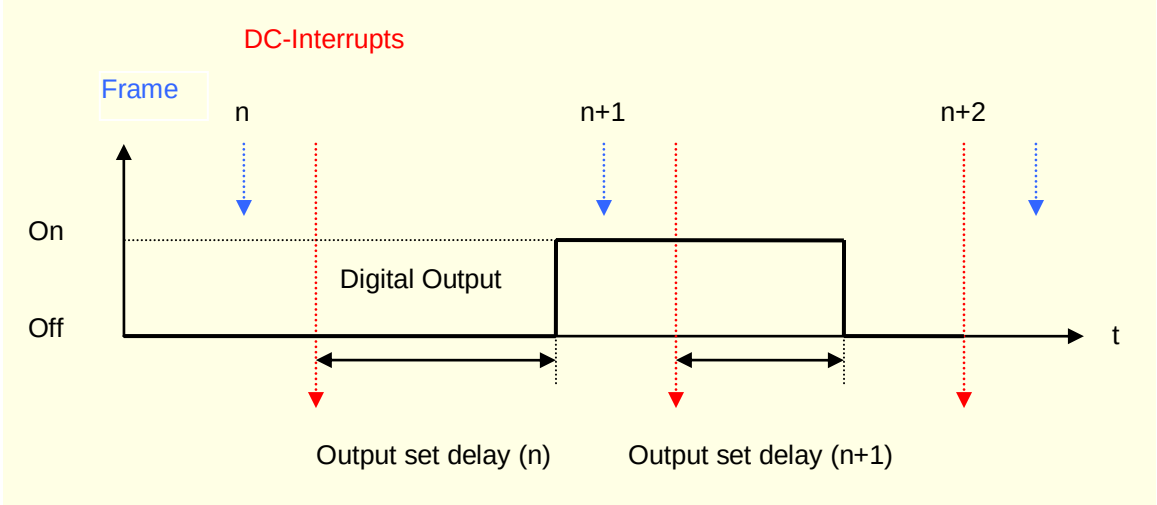
Output set delay		
Variable	**Data type**	**Explanation**
Output_0_0_Del	UINT	Output set delay in µs

In frame-synchronous mode



Frame-synchronous		
Frame	**Digital Output**	
	Variable	**Output set delay**
n	TRUE	Output set delay (n)
n+1	FALSE	Output set delay (n+1)

In DC-synchronous mode



DC-synchronous		
Frame	**Digital Output**	
	Variable	**Output set delay**
n	TRUE	Output set delay (n)
n+1	FALSE	Output set delay (n+1)

9.1.8. Analogue outputs (Counter/Posi2 5V only)

The variables define the voltage of the analogue outputs.

Analogue outputs		
Variable	**Data type**	**Explanation**
AnalogOutput_1	UINT	Analogue output 1

Output values see table voltage, page 53

9.1.9. Examples

Enable Counter
The counter is active, when the variable “EnableCounter_1” is TRUE.

```
Term2_EnableCounter_1:=TRUE; (*Release of the counter *)
Term2_Counting_1;            (*TRUE, if counter is enabled *)
Term2_Clockwise_1;           (*Count direction, TRUE, when up *)
```

Counter set/clear
Copying the contents of “SetValue_1” into the current value is executed by a rising edge to “SetCounter_1”. Execution is indicated by “CounterSet_1=TRUE”.
If “SetCounter_1” is reset (FALSE) again, “CounterSet_1” also becomes FALSE again.

```
Term2_SetValue_1:=diCounterValue ;    (*Copy a number into the source var*)
                                      (* 0 = Clear*)
Term2_SetCounter_1:=TRUE;             (*and copy to the counter current
                                        value*)
Term2_CounterSet_1;                   (*TRUE, if set*)
```

Set compare value
Configuration settings set in “Zähler 1 Optionen” are activated by the rising edge of the control bit “SetOptions_1”. The successful take-over of the options is confirmed with the status bit “OptionsSet_1” (e.g. Set compare function).

```
PROGRAM Initialisierung (Initialization)
VAR
    bInit: BOOL := TRUE;
    Step: USINT;
END_VAR
-------------------------------------------------------------------------------
-
IF bInit THEN
CASE Step OF
(*Select options, activate them by a rising edge to "Set_Options"*)
    0:   Term2_EnableCounter_1:=TRUE; (*Release counter *)
    Term2_EnableCompare_1:=TRUE;      (*Activate compare function *)
         Term2_ControlOutput_1:=TRUE; (*Compare function controls output *)
         Term2_SetValue_1:=10000;     (*Set value = 10000..*)
         Term2_SetCompare_1:=TRUE;    (*..use as compare value *)
         Term2_SetOptions_1:=TRUE;    (*Activate selected options *)
         Step:= 1;
(* Wait for confirmations "OptionsSet" and "CompareSet"*)
    1:   IF Term2_OptionsSet_1 AND Term2_CompareSet_1 THEN
              Step:= 2;
         END_IF
(* Set "Set_Options" and "SetCompare" in the starting position*)
```

```
    2:   Term2_SetOptions_1:=FALSE;
         Term2_SetCompare_1:=FALSE;
         Step:=0;
         bInit:=FALSE;
    END_CASE
END_IF
```

Set preset value
Copying the value of “SetValue_1” into the preset value is executed by a rising edge to “SetPreset_1”. The execution is indicated by “PresetSet_1=TRUE”.
If “SetPreset_1” is reset (FALSE) again, “PresetSet_1” also becomes FALSE again.

```
Term2_SetValue_1:=diPresetValue ;(*Copy a number into the source var*)
Term2_SetPreset_1:=TRUE;         (*and copy to the preset value*)
Term2_PresetSet_1;               (*TRUE, if set*)
```

Set maximum value
Copying the value of “SetValue_1” into the maximum value is executed by a rising edge to “SetMax_1”. The execution is indicated by “MaxSet_1=TRUE”.
If “SetMax_1” is reset (FALSE) again, “MaxSet_1” also becomes FALSE again.

```
Term2_SetValue_1:=diMaxValue ;   (*Copy a number into the source var*)
Term2_SetMax_1:=TRUE;            (*and copy to the maximum value*)
Term2_MaxSet_1;                  (*TRUE, if set*)
```

Digital output

see also page 92 Zähler 1 Optionen

The digital output can be controlled optionally by the variable "Output_0_0" or the compare function.
Decision is done by the variable "ControlOutput_1" (Set options see also page 100).
The current status of the output is read from the module and displayed in “In_Output_0_0”.

```
Term2_ControlOutput_1:=FALSE;    (*Term2_Output_0_0 controls output*)
Term2_ControlOutput_1:=TRUE;     (*Compare function controls output*)
Term2_In_Output_0_0;             (*Status of the output*)
```

Operating as A-B-Ref-Counter or Event Counter
see also page 92 Zähler 1 Optionen
The counter can be operated as A, B, Ref -Counter with self detection of the direction or as event counter. The selection is done by the variable “SelectEncoder_1” (Set options see also page 100).

```
Term2_SelectEncoder_1:=FALSE;    (*A, B, Ref with self detection of the
                                   direction*)
Term2_SelectEncoder_1:=TRUE;     (*Event counter at A*)
                                 (*B=FALSE:down, B=TRUE:up*)
```

Single and multiple counting
This option is valid in the event counter mode only (see also page 92 Zähler 1 Optionen).
The counter can count edges (all rising and falling edges) or pulses (only the rising edges).

The selection is done by the variable “SetResolution_1” (Set options see also page 100).

```
    Term2_SetResolution_1:=FALSE;     (*All edges*)
    Term2_SetResolution_1:=TRUE;      (*Pulses*)
```

Referencing
The counter can be set to preset value when a pulse occurs at the Ref input. The preset value can be 0, but also any other 32-bit number.

Task
An encoder with 500 pulses provides 2000 increments per turn in 4-fold mode.
Every Ref pulse shall set the counter to the preset value 2000. It shall be counted down to 0 within 1 turn. (The counting direction is determined by the turning direction of the encoder.)

```
PROGRAM Referenzierung (Referencing)
VAR
    bInit: BOOL := TRUE;
    StepInit: USINT;
    bInitReady: BOOL;
    Step: USINT;
END_VAR
-------------------------------------------------------------------------------
-

(*1. Initializing: Enabling of the counter and setting of the preset value*)
IF bInit THEN
    CASE StepInit OF
(*Selecing of the options and setting them by a rising edge of "Set_Options"*)
    0:   Term2_EnableCounter_1:=TRUE;
         Term2_SetValue_1:=2000;
         Term2_SetPreset_1:=TRUE;
         Term2_SetOptions_1:=TRUE;
         StepInit:=1;
(*Wait for confirmations "OptionsSet" and "PresetSet"*)
    1:   IF Term2_OptionsSet_1 AND Term2_PresetSet_1 THEN
              StepInit:=2;
         END_IF
(*Reset "Set_Options" und "Set_Preset" into the start position*)
    2:   Term2_SetOptions_1:=FALSE;
         Term2_SetPreset_1:=FALSE;
         StepInit:=0;
         bInit:=FALSE;
         bInitReady:=TRUE;
    END_CASE
END_IF
```

```
(*2. Controlling of the referencing*)
IF  bInitReady THEN
    CASE Step OF
    (*Switch on the referencing mode*)
    0:   Term2_EnableReferencing_1:=TRUE;
         Step:=1;
    (*Wait for a referencing pulse*)
    1:   IF Term2_Referenced_1 THEN
              Step:=2;
         END_IF
    (*Reset of the referencing message*)
    2:   Term2_ResetReferenced_1:=TRUE;
         Step:=3;
    3:   IF NOT Term2_Referenced_1 THEN
    (*Exit reset of the referencing message*)
         Term2_ResetReferenced_1:=FALSE;
    (*Switch off the referencing mode*)
         Term2_EnableReferencing_1:=FALSE;
         Step:=0;  (*reference in the next turn again*)
         END_IF
    END_CASE
END_IF
```

Capture

A falling edge at the digital input 1 can be used as trigger in order to save the current counter value (capture). You get a message in the status bit “Captured_1” that a capture event has appeared. You have to reset “Captured_1” by “ResetCaptured_1” that the next capture event can be indicated.

```
Term2_Input_0_1;        (*Status of input 1*)
Term2_Select_1:=4;      (*Copy capture register to Term2_SelectedValue_1*)
Term2_Selected_1;       (* =4, if capture value in Term2_SelectedValue_1*)
Term2_SelectedValue_1;  (*Here you can read the capture value.*)
Term2_Captured_1;       (*A capture event has appeared.*)
Term2_ResetCaptured_1;  (*Reset of Term2_Captured_1*)
```

Digital inputs (Input_0_x)

The statuses of the digital inputs are indicated in the variables “Input_0_x”.
Permanent additional function: The current counter value is saved in the capture register when a falling edge appears at Input_0_1.

```
Term2_Input_0_0;        (*Status of input 0*)
Term2_Input_0_1;        (*Status of input 1*)
Term2_Input_0_2;        (*Status of input 2*)
Term2_Input_0_3;        (*Status of input 3*)
```

Analogue outputs (Counter/Posi2 5V only)
The output values of the analogue outputs are written into the variables “AnalogOutput _x”.

```
Term2_ AnalogOutput_1:= 16#7FFF; (*Set AnalogOutput_1 to +10V*)
Term2_ AnalogOutput_2:= 16#8000; (*Set AnalogOutput_2 to -10V*)
```

Output values see table “AI4/8-U, Analogue values voltage”.

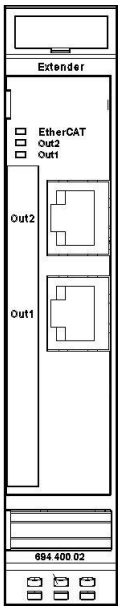
9.1.10. Technical data

Counter/Posi2 5V	
Label	E-I/O COUNTER/POSI 2 5V
Part no.	204801700
Plug-in connector	36-pole 204800300 (not part of the module)
Encoder	2 A, B, Ref
Encoder type	5 V (RS422)
Count rate	max. 400 kHz
Digital inputs	8
Input delay	1 ms
Signal level	**Off:** -3 … 5 V, **On:** 15 V … 30 V (EN 61131-3, Type1)
Digital outputs	2
Max. current	2 A per output
Fieldbus	EtherCAT 100 Mbit/s
EtherCAT file	Berghof EIO Modules.xml
WxHxD	25x120x90 mm
Mounting	35 mm DIN top hat rail
Controller	ASIC ET1200
E-bus port	10-pole system plug at the side wall
Term. module	not required
E-bus load	300 mA
Analogue outputs	2
Voltage	-10 V ...+10 V
Resolution	12 bit
Power supply	
Logic	by EtherCAT coupler via E-bus plug
Power	24 V DC -20% +25%
Galvanic separation	Separated from one another and versus the bus
Storage temperature	-25 °C…+70 °C
Operating temperature	0°C…+55°C
Relative humidity	5%...95% without dewing
Protection	IP20
Interference immunity	Zone B

Blank page

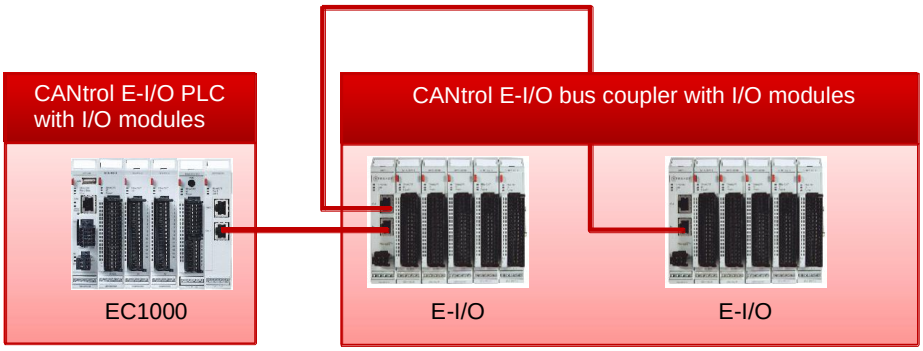
10. Extender

10.1. Extender 2 Port



Extender 2 Port

The purpose of the CANtrol E-I/O Extender is the extension of a CANtrol E-I/O block or an EC1000 by EtherCAT slaves, which have a standard 100 base TX connection.
The Extender module changes the transmitting physics of LVDS (E-bus) on twisted pair.
The module is usually arranged thereby at the end of the block.
In addition, the Extender can be used in arbitrary place behind the bus coupler and/or the EC1000 PLC controller.
Thus EtherCAT slaves can also be connected in star topology.



2VF100531DG00.cdr

10.1.1. Terminals

Supply of the module
via E-bus

EtherCAT (RJ45 socket)
OUT1: Output port (to the next EtherCAT device)
OUT2: Output port (to the next EtherCAT device)

10.1.2. Status LEDs

“EtherCAT” LED
The LED labeled “EtherCAT” indicates the state of the EtherCAT ASIC.

EtherCAT		
State	**LED flash code**	**Explanation**
Init	Red, on	Initializing, no data exchange
Pre-Op	Red/green, 1:1	Pre-operational, no data exchange
Safe-Op	Red/green, 3:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

“Out2” LED/“Out1” LED
The “Out2” LED and the “Out1” LED indicate the physical state of the Ethernet port they are allocated to.

Out2 / Out1		
State	**LED flash code**	**Explanation**
Not connected	Off	No Ethernet connection
Connected	Green, on	Connected to Ethernet
Traffic	Green, flashing light	Exchanging telegrams

10.1.3. Function

The Extender 2 port module has actually 4 ports. Name 2 port module was chosen because of the 2 standard 100 base TX (OUT1, OUT2) RJ45 connections. Another 2 ports are covered by the E-bus.

It is important to the configuration in which sequence the connections are operated, i.e. which way the EtherCAT frame runs.

Function		
Port	**Connection**	**Sequence**
Port A	E-Bus In	1
Port B	Out 1	3
Port C	Out 2	4
Port D	E-Bus Out	2

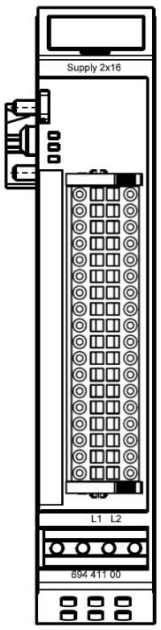
10.1.4. Technical data

Extender 2 Port	
Label	E-I/O EXTENDER 2 PORT
Part no.	204801500
Function	Extension of a CANtrol E-I/O block resp. of an EC1000 Transformation of transmission physics from LVDS (E-bus) to 100Base-TX
Controller	ASIC ET1100
Baud rate	100 Mbit/s
Cable	CAT5
Cable length	max. 100 m
EtherCAT Connection	2 x RJ45
Power supply	via E-bus
E-bus load	160 mA for Out1 / 210 mA for Out1 + Out2

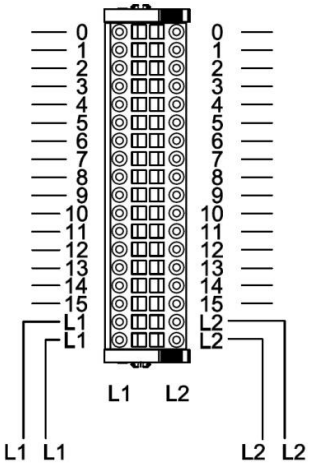
Blank page

11. Supplement

11.1. Potential Distributor 2 x 16



Front view of Potential Distributor



Connections

11.1.1. Terminals

The module Potential Distributor 2 x 16 has 2 separate potential lines.
It distributes the potential (optional 0 V DC or 24 V DC) attached at the pins L1 or L2 on the pins 0 to 15 of the same row.
The E-bus is passed on from the previous one to the next module.

11.1.2. Status LEDs

The module has no status LEDs.

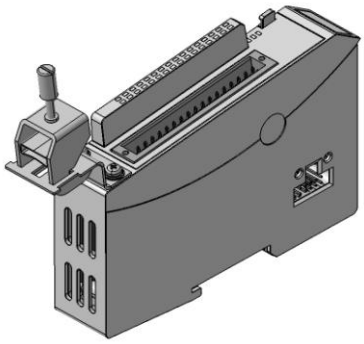
11.1.3. Function

2-wire or 3-wire terminals for digital I/O modules

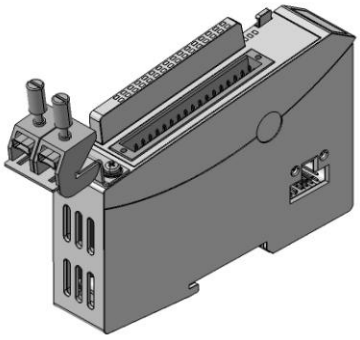
11.1.4. Technical data

Potential Distributor	
Label	Potential Distributor 2 x 16
Part no.	204802300
Plug-in connector	36-pole 204800300 (not part of the module)
E-bus port	10-pin system plug in side wall
E-bus load	none

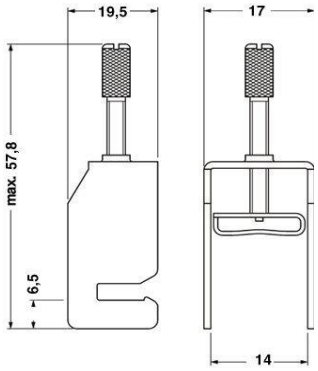
11.2. Shield connection terminal block



Shield connection terminal block 1 x 14 mm;



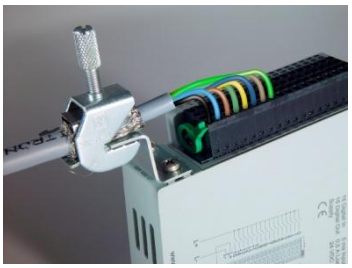
2 x 8 mm



Measurements of the clamp 14 mm

11.2.1. Terminals

The shield connection terminal block consists of the shield clamp, the clamp holder, 2 screws M3x5, 2 washers and 2 spring washers. Fasten the clamp holder with the 2 screws by using the washers and spring washers on the housing of the CANtrol E-I/O module.
Use the two tapped holes on the front side below. They are provided for it.



Shield connection terminal block 14 mm

11.2.2. Function

The shield connection terminal block makes it easy to apply the cable shield. The shield connection terminal block conducts the potential of the cable screen on the DIN top hat rail on which the CANtrol E-I/O module is picked up.

WARNING

The mounting rail must have a suitable earth connection.

The shield connection terminal blocks may not be used as strain relief. See also section 3.1.1 Earth

11.2.3. Technical data

Shield connection terminal block	
Label	E-I/O Shield connection terminal block 2 x 8 mm
Part no.	204802400

Blank page

12. Annex

12.1. Environmental Protection

12.1.1. Emission

When used correctly, our modules do not produce any harmful emissions.

12.1.2. Disposal

At the end of their service life, modules may be returned to the manufacturer against payment of an all-inclusive charge to cover costs. The manufacturer
will then arrange for the modules to be recycled.

12.2. Maintenance/Upkeep

WARNING	**Do not insert, apply, detach or touch connections while in operation – risk of destruction or malfunction.** Disconnect all incoming power supplies before working on our modules; this also applies to connected peripheral equipment such as externally powered sensors, programming devices, etc. All ventilation openings must always be kept free of any obstruction.

→ The modules are maintenance-free when used correctly.

→ Clean only with a dry, non-fluffing cloth.

→ Do not use detergents!

12.3. Repairs/Service

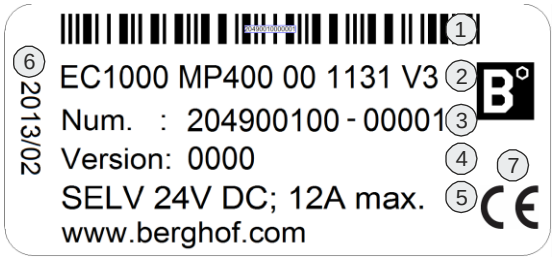
WARNING	Repair work may only be carried out by the manufacturer or its authorised service engineers.

12.3.1. Warranty

Sold under statutory warranty conditions. Warranty lapses in the event of unauthorised attempts to repair the equipment and/or product, or in the event of any other form of intervention.

12.4. Nameplate

Nameplate descriptions (example)



2VF100080DG02.cdr

1 **Barcode**
same as identification number.

2 **Module type**
plain-text name of module.

3 **Identification no.**
is the unique labeling of the module, consists of two elements.
Part no. (the first nine digits)
The designation of this number suffices for ordering a module.
The delivery takes place in each current hard- and software version.
Serial no. (five digits behind the hyphen)

4 **Version**
defines the design-level of the module as supplied ex-works.

5 **Supply voltage**

6 **Production date**
year / calendar week of the production.

7 **CE mark**

NOTICE

The 'Version' (supply version) panel specifies the design-level of the module as supplied ex-works.

When replacing a module, users, with the CNW (CANtrol Node Wizard) tool, can read off the current software version of the newly supplied module, and then reload their 'own' software version for a particular project if necessary. With the latter in mind, before the download you should always keep a record of the existing software levels in your project documentation (software version, node IDs, baud rate, etc.).

12.5. Addresses and Bibliography

12.5.1. Addresses

CAN in Automation; international manufacturers and users organisation for CAN users in the field of automation:
CAN in Automation e.V. (CiA)
Am Weichselgarten 26
D-91058 Erlangen / Germany
headquarters@can-cia.de
www.can-cia.de

→ CiA

EtherCAT Technology Group
ETG Headquarters
Ostendstraße 196
D-90482 Nuremberg / Germany
info@ethercat.org
www.ethercat.org

→ ETG

Beuth Verlag GmbH, 10772 Berlin

or

VDE-Verlag GmbH, 10625 Berlin

→ DIN-EN Standards

VDE Verlag GmbH, 10625 Berlin

or

Internet search: www.iec.ch

→ IEC Standards

12.5.2. Standards/Bibliography

Standard	Label
IEC61131-1 / EN61131-1	Programmable controllers Part 1: General information
IEC61131-2 / EN61131-2	Programmable controllers Part 2: Equipment requirements and tests
IEC61131-3 / EN61131-3	Programmable controllers Part 3: Programming languages
IEC61131-4 / EN61131Bl1	Programmable logic controllers Supplementary Sheet 1: User guidelines
IEC61000-6-4 / EN61000-6-4	German EMC Standard: Emitted interference
IEC61000-6-2 / EN61000-6-2	German EMC Standard: Noise immunity
ISO/DIS 11898	Draft International Standard: Road vehicles - Interchange of digital information - Controller Area Network (CAN) for high-speed communication
DIN EN ISO 13849-1	Safety of machinery: Safety-related parts of control systems (Part 1)
Bibliography	A variety of specialist publications on the CANbus is available from specialist bookshops, or can be obtained through the CiA users' organisation.

Notice: Our Technical Support team will be glad to provide other literature references on request.